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October 4, 1923

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Difficult River Crossing Made By Double-Deck Bridge

Leveling Moro do Costello in Rio de Janeiro

Economical Use of Irrigation Water

Also:

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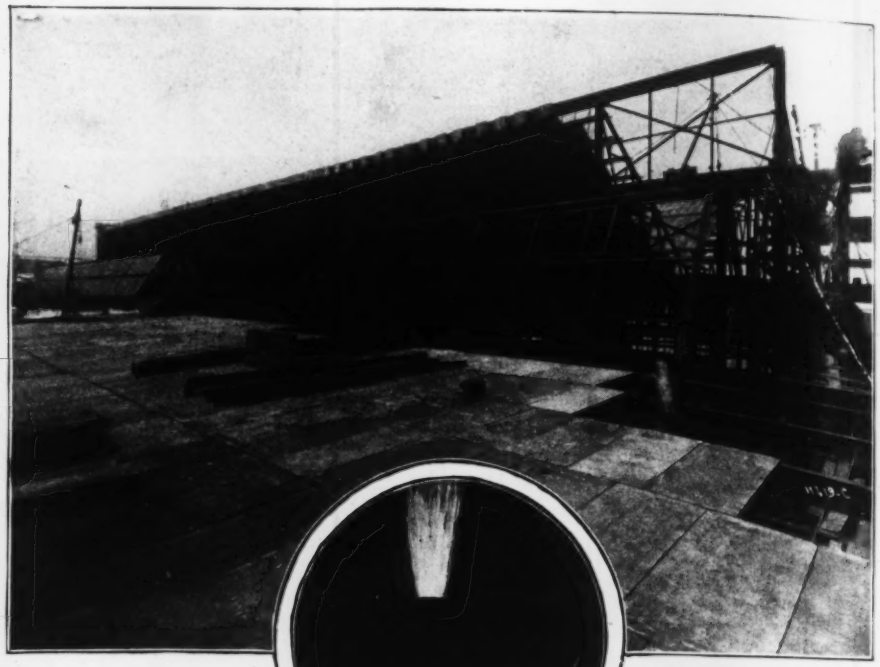
Leveling a hill in Rio de Janeiro by hydraulic sprays



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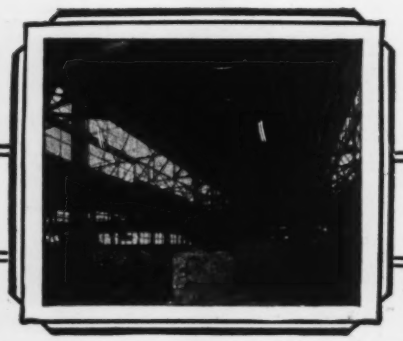


Interior view of Pullman foundry

"The Roof for Permanence"

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. McGRAW, *President*

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, *Editor*
FRANK C. WIGHT, *Managing Editor*

Volume 91 — NEW YORK, OCTOBER 4, 1923 — Number 14

A Useful Service

ALMOST necessary service can be rendered by the committee just authorized by the American Society of Civil Engineers to collect data on the behavior of structures in the Japanese earthquake. There were enough modern buildings and other engineering works in the stricken zone to provide information far ahead of anything hitherto available and it is imperative that some orderly and authoritative means be provided to secure this information, digest and analyze it and put it before the profession. This the civil engineers, with the co-operation of other technical societies where they can co-operate, purposes to do. The earthquake zones of the world are comparatively limited but they embrace some of the best and most livable country in the world. Engineers need all the knowledge they can acquire as to the best way of providing the people of these zones with safe and durable structures.

Road Taxes

LESS than 5½c. of the general taxpayer's dollar in 1921 went to highways. During that year about one billion dollars were spent in highway construction and maintenance. These figures are given by John E. Walker, former tax adviser to the United States Treasury. They are of vital significance to highway officials. If reports from Washington forecast accurately the attitude of members of Congress, there will be a strong effort at the coming session to curtail highway appropriations, on the plea of tax reduction. The reaction against highway expenditures, of which *Engineering News-Record* sounded a warning a year ago, has lost none of its impetus in state legislatures. Of the many causes which have led up to this reaction, the greatest is the growing tax burden. How small a portion of this is imposed by highway improvement is not generally realized. This is largely the fault of highway officials. They have not told the people plainly who is paying the bulk of the cost of our improved roads.

Fining Winter Idleness

UNEMPLOYMENT is becoming more generally considered the responsibility of employers. Wisconsin will this winter, according to press dispatchers, discuss in its house of representatives an act providing unemployment insurance. The act has already passed the state senate. Nominally it is an insurance act. Virtually it is a penalty on employers for not eliminating seasonal business. In essence it compels an employer who lays off an employee not because of the employee's fault, to pay him a dollar a day for thirteen weeks. Obviously a big sociological problem is involved. As engineers and contractors, however, the readers of *Engineering News-Record* are chiefly concerned in the effect of the law on seasonal construction. The construction industry has been the most callous of employers in turning loose its workmen when the busy season of summer had passed. There is no work in winter, it has said, and complacently distributed quitting checks. Getting the industry to think that winter idleness is not a divine ordinance is a hard task. Perhaps a ninety-dollar fine for each employee discharged will bring a more open mind. One is inclined to applaud the experiment.

Farmers Want St. Lawrence Canal

BECAUSE the agitation for the St. Lawrence ship canal is not getting quite as much publicity as it did some years ago it must not be thought that the project is dead. The fact is that conditions of the past few months have only added fuel to the flame of the demand for the waterway. Although wheat constitutes a very small part of the revenue producing crops of the nation and a smaller part of the income of the average farmer it has become the index by which farm prosperity is popularly measured. This is notoriously a bad wheat year and whatever the cause the farmer is pretty well persuaded that high rail rates make up the major part of the trouble. The St. Lawrence shipway would be pre-eminently a wheat-carrying channel. Whether or not it will ever prove profitable for other kinds of freight is something only operation—with its possible relocation of freight routes and development of economical transfer machinery—can tell, but for wheat, which can as readily be brought to lakeside elevators as to any other central distributing point, carrying charges will certainly be lower. That being the case, the farmer sees in the canal the way out of his difficulties. It does not matter whether or not it may be cheaper in the long run for the country to build more railroads or for the railways to reduce rates, this appears to be the easy way out, just as for the last fifty years the waterway has appeared to be the easy way out of all high transportation rate difficulties. So far the waterway has disappointed its advocates. Possibly the St. Lawrence route will, too. But the opponents to the scheme will do well to reckon with the western farmers who are now more than ever in a mood to demand the experiment.

Delusions of Persecution

ONE of the most characteristic exhibitions of the waterway mania is that now being given by the advocates of the New York State Barge Canal. For nearly ten years that much-advertised waterway has been struggling to demonstate its usefulness. For a large part of that time the state officials in charge have been favorable to water carriage and have done all in their power to promote the use of the canal, but the results have been disappointingly small. There has been some increase in freight carriage, but certainly not enough to prove that the canal will ever be worth

the $170,000,000 it cost the State of New York. Now the waterway enthusiasts have taken a new tack. Their pet project, they say, is about to become the prey of the politicians of both parties who are engaged in devious effort to scrap the canal entirely or else to convert it into a water-power scheme. The case of the waterway men is pathological. For years they have suffered from delusions of persecution. If either on the Mississippi or the Mohawk they spent nearly the energy to prove by service the economies of water transport as they do in complaining of the unfairness of their competitors, inland waterway freight carriage would today be more than the academic proposition it really is.

Red Tape and a Pontoon Bridge

THE War Department has announced that government material cannot be used without sanction of Congress to build a pontoon bridge across the Connecticut River at Springfield, Mass., to relieve the situation caused by the burning of the North-End bridge on Sept. 8. Evidently there must be some sharp distinction between letting army engineers practice at bridge building by using this sacred government material to build a bridge across the Potomac at some point where it is of no use to anyone and letting them do the same thing across the Connecticut at Springfield, where the bridge would be of great value to a large community. The War Department might well arouse itself to aggressive action in such peace-time emergencies, instead of hiding behind a screen of red tape and precedent. This is an admirable opportunity for the department to go before the people with a much better face when it has to appeal to them for funds to carry on just such work as training men to build pontoon bridges.

Sheets and Pillow Slips

MANY comforts and conveniences have been provided in recent years for common labor in Western construction camps. There is a limit beyond which this cannot be carried, although the demands of labor organizations have sometimes raised the question as to where it could be fixed. Good food, bunk houses with good light and ventilation, handy hot and cold showers, have all been requisites of the successful camp. In recent years contractors found it necessary to keep these facilities up to par to avoid an excessive labor turnover because labor knew where to find camps that *did* provide good food and quarters.

On some jobs now the contractor has gone even further; he provides bed linen. Formerly all laborers carried a blanket roll commonly called a "bindle," or, "turkey," and it was the universal custom for every man to take care of his own bed. When one large camp equipped all bunk houses with sheets and pillow slips the experiment was watched with much interest. Now, a number of large projects with anywhere from one to eight or ten camps provide every man on the job with complete beds, including mattress, blankets, pillows, sheets and pillow slips, the camp organization changing and washing the sheets and inspecting blankets at stated intervals. The Big Creek project of the Southern California Edison Co., operating under this system, does not allow a blanket roll to come into the camp. The Skagit project of the City of Seattle, from the start of the first camp, has provided bed linen for common labor. More recently even smaller contractors, in order to attract men to short-time jobs, have frequently made it a practice to provide fully equipped bunk houses.

The plan has a two-fold value; it (1) maintains self-respect of the men and makes them feel that they are having the best of care and it (2) improves sanitary conditions by preventing the spread of vermin and disease that would otherwise go from camp to camp in the blanket roll. After a year or two of experience in supplying bed linen and including the maintenance of clean beds as part of the camp organization duties, the consensus of opinion among those who use this plan is that *it pays*. The charge made to the men for linen and blankets—say about $1 per month—may not cover the actual cost, but any small loss is much more than made up by the improved attitude of labor.

Valuation Principles Still Vague

ON THE correspondence page of this issue Prof. C. C. Williams, of the University of Illinois, makes a plea for the reproduction-cost-new theory of valuation as opposed to the prudent-investment theory which has been tentatively advocated by the minority justices in several of the recent Supreme Court decisions and which, the professor thinks, was defended in an earlier editorial in this journal. That editorial was not intended to support the prudent-investment theory at the expense of the reproduction-cost-new theory, but it was meant to show the complication in trying to set up one base method of valuation.

Unfortunately, it appears that the process of valuation cannot be reduced to any simple formula. It is true that the Supreme Court rulings for many years have leaned toward the reproduction-cost-new method, but they have by no means pronounced it absolute. The cost today to reproduce the property has been advanced as one of the elements—occasionally a governing element—in determination of fair value; but even where it is possible simply to arrive at that cost (which it rarely is) the court has not always accepted it as the final value. Justification for the investment, the degree of use, the market value of the property as expressed in the securities—all elements in the so-called prudent-investment theory—have always entered into the determination of value as reached by the highest court. That court has always recognized, we think, that the public should not be made to pay a toll for the mistakes which public utility promoters have made.

No better example of the fog that surrounds valuation or of the difficulty of arriving at an exact figure in valuation could be found than the report of the Interstate Commerce Commission on the final valuation of the San Pedro, Los Angeles & Salt Lake R.R. just made. The commission in this case gives as $45,000,000 the final single-sum value of the property for rate-making purposes as of July 1, 1914. This is a majority report concurred in fully by eight of the eleven members and partly by two others, and yet the report itself shows that there were as many methods of arriving at this exact sum as there were members of the commission. The sum of $45,000,000 does not represent prudent investment. It does not represent reproduction cost new, or stock value, or selling price, or any other one thing. It is merely a figure which ten men are willing to agree

upon as the value in 1914 of a small railroad, that figure to be used as a base for rate making at some date years after 1914, with the method to be followed in bringing the value up to the rate-making date left unsettled. It is, as Commissioner Meyer says, the approximate investment on which those devoting this property to common carrier service were entitled to a fair return in 1914.

While, therefore, engineers will heartily concur in Professor Williams' suggestion that an adherence to one method of valuation would remove much of the fogginess which now beclouds the whole subject, there is little chance, it seems to us, that it can be made a simple process. There is a chance as time goes on and the records of public utilities are kept more precisely and the current prices of material and labor are more fully a matter of record, that a fair value will be more readily established than it is now when records are scarce and past unit prices doubtful. In the future, with the reproduction-cost-new theory governing, as it has been in the past, but not absolute, there should be a more close agreement between the public idea of the value of a utility and the idea of the owners themselves.

A Step Ahead in a Major Problem

A MAJOR problem in both local and national transportation is moved appreciably nearer solution by the agreement last week between the railroads and the Port of New York Authority in the matter of the New Jersey marginal railroad. The agreement is important in that it breaks a deadlock which has been hampering the proper delivery of freight into New York—which means that the whole country as well as New York has been hampered—but it is equally important because it marks the acknowledgment by the railroads of the force of public opinion and a definite step ahead in the establishment of the power of the Port of New York Authority.

Heretofore, despite the wording of the treaty which established the authority, there had been some doubt as to how much pressure it could bring to bear in case its powers were in question. Just such a doubt was in the minds of the railroad officials when the hearing on the marginal belt line opened before the Interstate Commerce Commission last spring. But the recent about face of the same officials, representing the most powerful railroads in this country, is ample evidence of how definitely the powers of the port authority were established at that hearing. Such being the case the authority is now in a much better position than ever before to proceed with its "comprehensive plan for the development of the Port of New York."

The marginal belt line in New Jersey, the subject of the recent action, is only a small part of that plan. There are other details that call for immediate action. The chief one is the so-called middle belt line No. 1, a belt line starting from connections with the New Haven and the New York on Long Island and running down to Bay Ridge and across by a tunnel to the New Jersey and thence up to connect with all the trunk lines on that side. The railroad companies have already taken steps toward building this latter section but the connection across the bay to Brooklyn is badly needed to divert the through traffic for New England away from the congested areas along the west shore of the Hudson. The port authority's plan calls for the construction of this connection as a tunnel under the Upper Bay from Bayonne to Bay Ridge. But under legislative enactment the City of New York is now building a tunnel for similar purposes under the Narrows from Staten Island to Bay Ridge. Obviously both tunnels should not be built, at least not for many years to come, and the railroad connections for the two tunnels can be altered to suit whichever tunnel it is deemed most advisable to construct. Either route can be made to suit the needs of traffic. And as far as immediate needs are concerned the Narrows tunnel has the advantage over the Upper Bay tunnel in that it is only half as long and is already under construction.

Now that the port authority has its feet on solid ground it would seem that it should take some definite action towards completing this major belt line. The conditions are most favorable. The city government is determined that the Narrows tunnel shall be built and it has legislative "mandate" to support its action. But it lacks the one thing needful—money. If it spends the necessary millions on this tunnel it will have little left for other needed utilities such as subways. It is here that the authority can display its usefulness to the city and at the same time perhaps remove much of the antagonism towards it that now exists in the present city administration. It can, under the laws which created it, revise its plan to make the Narrows tunnel a part of that plan, issue bonds to finance its construction, and take over the construction from the city, thereby allowing the city to use its moneys for other purposes.

But before the port authority can take this step the city administration must publicly abandon the idea that the Narrows tunnel can be used as a combined freight and passenger tunnel which will be able to handle the great volume of freight that will be routed through it and at the same time give Staten Island a frequent passenger train service to Manhattan Island. The passenger use of the tunnel has been minimized in the engineering reports but has been played up very strong by the political friends of the city administration, obviously with an eye toward the votes to be had on Staten Island. The residents there would do well if they were to recognize the hopelessness of traffic relief through this tunnel and ask the city authorities to let it stand on its merits as a freight tunnel to develop the industrial potentialities of the Island.

The Narrows tunnel issue is one which the port authority must meet no matter what the city may do, for if the Narrows tunnel is built by the city with freight connections to the Baltimore & Ohio on Staten Island a large part of the freight which would otherwise have gone through the port authority's proposed tunnel will be diverted to the Narrows tunnel and the port authority will hardly be able to demonstrate the economic necessity for its tunnel under the bay, a demonstration it is required by law to make before it can issue bonds to finance the tunnel. Just how it meets this issue will be a fair indication of whether it intends to carry out the spirit or the letter of the treaty which created it. Some years ago we pointed out that the Narrows tunnel controversy between city and the interstate body afforded a fine opportunity for the art of compromise. Now that the authority has won its first skirmish it is in an exceptionally strong position to initiate a move toward an adjustment which will work to the benefit of both sides.

Solve Complicated River Crossing with Double-Deck Bridge

New Reinforced-Concrete Bridge Across Black River at Watertown, N. Y., Has Upper and Lower Decks —Concrete Arch Design and Construction Complicated by This Arrangement

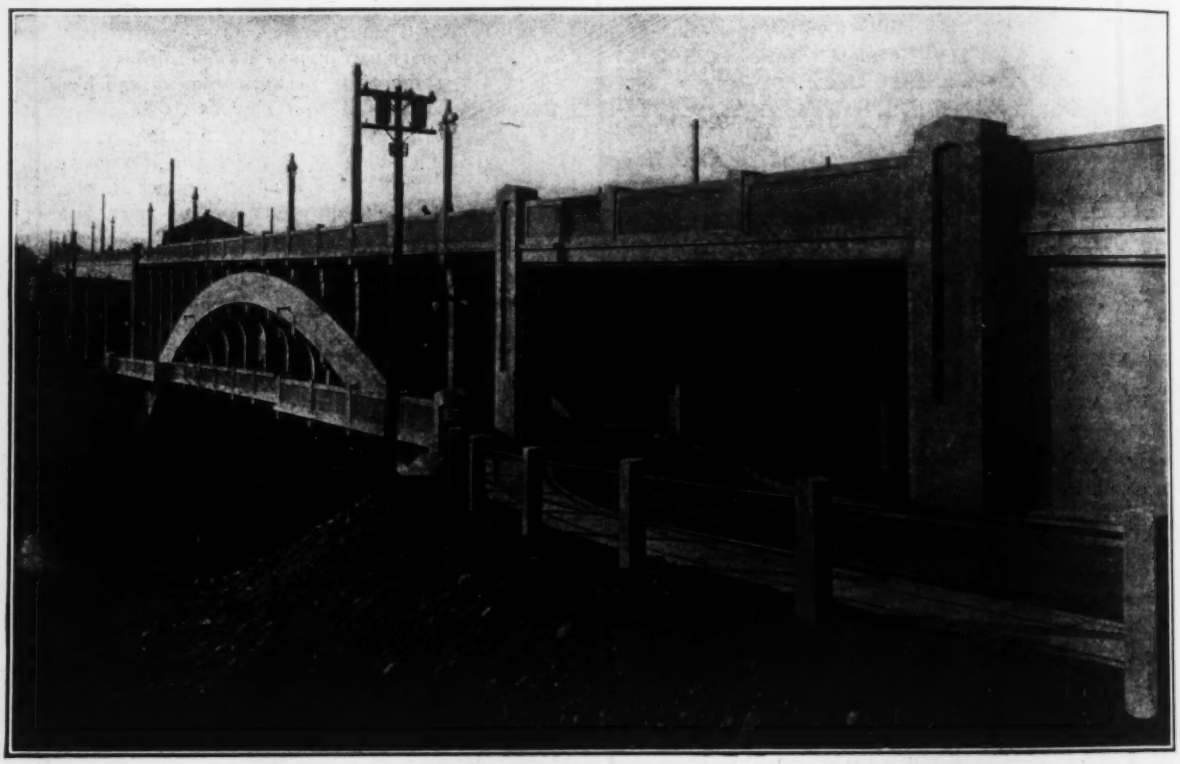
By E. H. Harder
Concrete-Steel Engineering Co., New York City

A DOUBLE-DECK reinforced-concrete arch is one of the outstanding features of a grade-crossing elimination project recently completed in the city of Watertown, N. Y. This bridge, known as the Court Street Bridge, eliminates a dangerous crossing of one of Watertown's crowded thoroughfares over an important branch line of the New York Central & Hudson River R.R.

An 86-ft. flat barrel arch span of reinforced concrete now carries Court St. over the same tracks at a location a little to the east of the former grade crossing. From a point over this arch, the new grade of Court St. is 4.5 per cent to the south, toward the center of the city, and 5.3 per cent toward the north and over the Black River. From the north end of the north abutment of the arch over the railroad tracks to the south bank of the Black River, a distance of 150 ft., the structure consists of three continuous girder spans. Each span measures 48 ft. 8 in. center to center of supports.

North of these girders and spanning the river is the double-deck reinforced-concrete arch of 195-ft. span length between abutment faces. The grade of the upper deck is 5.3 per cent, and carries the new realignment of Court St. over the Black River. As so far described, this elimination project would have deprived property owners between the railroad tracks and the south bank of the river of easy access to the north bank of the stream. With the abandonment of the old steel truss across the river, a detour would be necessary which would have greatly reduced the value for business purposes of the above-mentioned property. A lower deck carried by this 195-ft. span readily solved this problem since this deck virtually replaced the above-mentioned truss.

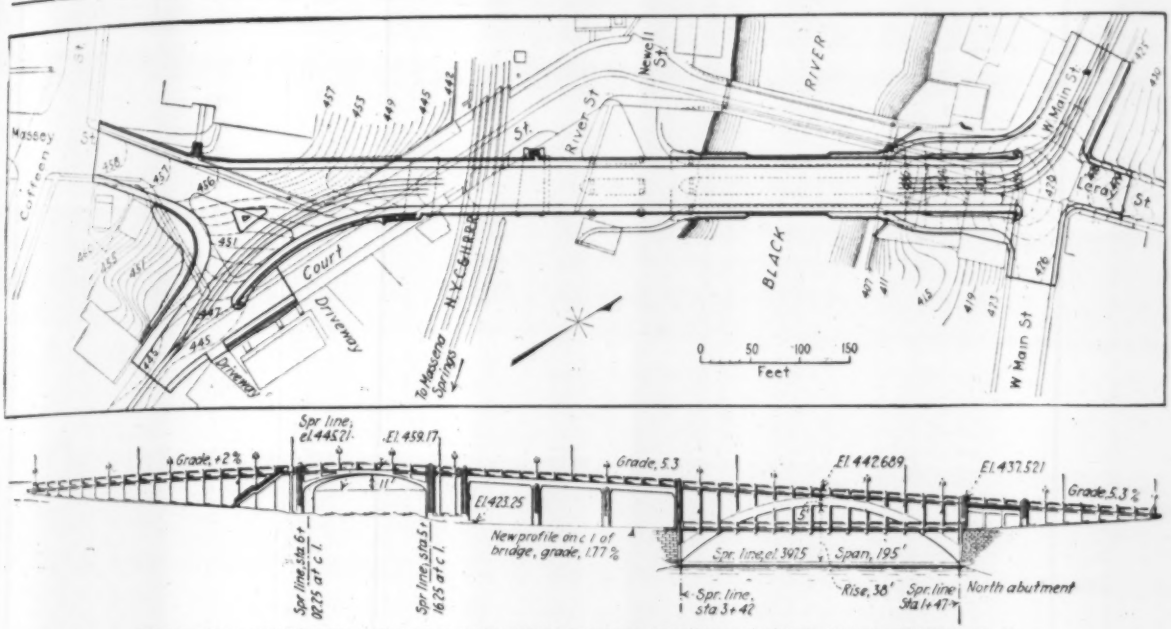
The double-deck arch has four ribs, each 6 ft. wide, except for a slight increase of width at the ends. The clear distances between these ribs are 13 ft., 3 ft. and 13 ft. The spread of 3 ft. between the inner pair of ribs provides ample room for a 10-in. gas main, a 12-in. water main and several 3-in. conduits. The city has erected a wooden enclosure to protect these mains against the extreme cold of winter.



BRIDGE ACROSS BLACK RIVER, WATERTOWN, N. Y., WITH TWO DECKS

The roadway over the upper deck is 38 ft. wide from curb to curb flanked by a 7-ft. sidewalk along each side of the bridge. Straight slab work was used throughout the upper deck because of the simplicity of construction. These slabs are supported on the four arch ribs by thin transverse walls. Reinforced-concrete girders, built into these walls, bridge the 3-ft. and 13-ft. gaps between arch ribs and carry the upper deck slabs above the lower roadways. Expansion joints were provided in these slabs at the points shown in the drawings.

Like the upper deck, the lower one also consists of



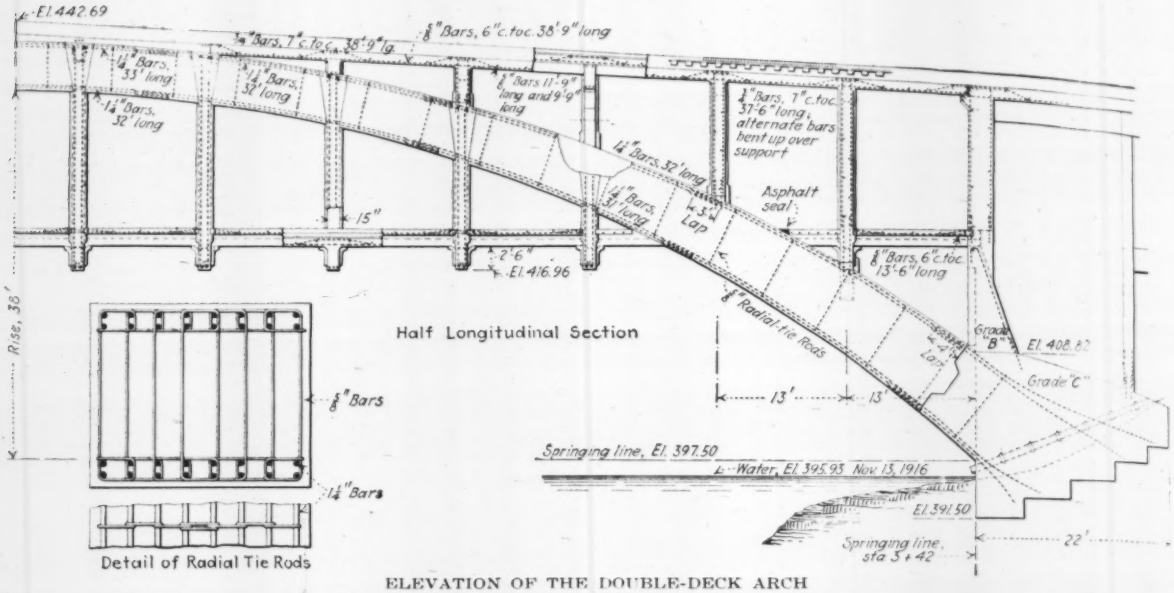
PLAN AND ELEVATION OF DOUBLE-DECK COURT STREET BRIDGE, WATERTOWN, N. Y.

slabs supported on transverse girders which in turn are hung from the four ribs. Near the abutments, the lower deck lies above the extrados of the ribs, and at such panel points the construction is supported on walls and transverse girders in the same manner as described for the upper deck. The lower deck sidewalk slabs are carried on cantilevers which are really continuations of the suspended transverse girders. At the ends of the arch, these sidewalks project beyond the faces of the outside rib, while at the center of the span they lie directly beneath the ribs. This arrangement saves weight and unnecessary sidewalk space. The lower deck is level from abutment to abutment.

In order to avoid undue tensile stresses in the hangers, it was decided to design the entire structure so that most of the dead-load of the lower deck would be carried by the hanger bars before these bars would be surrounded by concrete. With that object in mind, the upper ends of the eight 1-in. square hanger bars were secured in the concrete of the arch rib. At one side of the hanger a wedge-shaped opening was made through the arch rib. The hangers were then designed with a curbed flare which completely covered the intrados end of this wedge-shaped opening. After all the dead-load of the lower deck had been applied, except the weight of the parapet and the pavement, forms for the hangers were built and filled with concrete through the opening in the arch. Since this procedure necessitated that the arch be freed from its centering, an analysis was first made to determine the strength of the rib with openings 2 ft. wide and supporting the weight of the rib and the entire lower deck minus the weight of pavement and parapet.

The centering for the arch was built in two parts. The lower one consisted of pile bents with timber caps and stringers thoroughly cross-braced and built to the elevation of the bottoms of the lower deck girders. Above this part, the centering was built to conform to

LEFT: INSIDE VIEW OF ROADWAY. RIGHT: LOWER SIDEWALK CUT IN TO SAVE SPACE AND WEIGHT

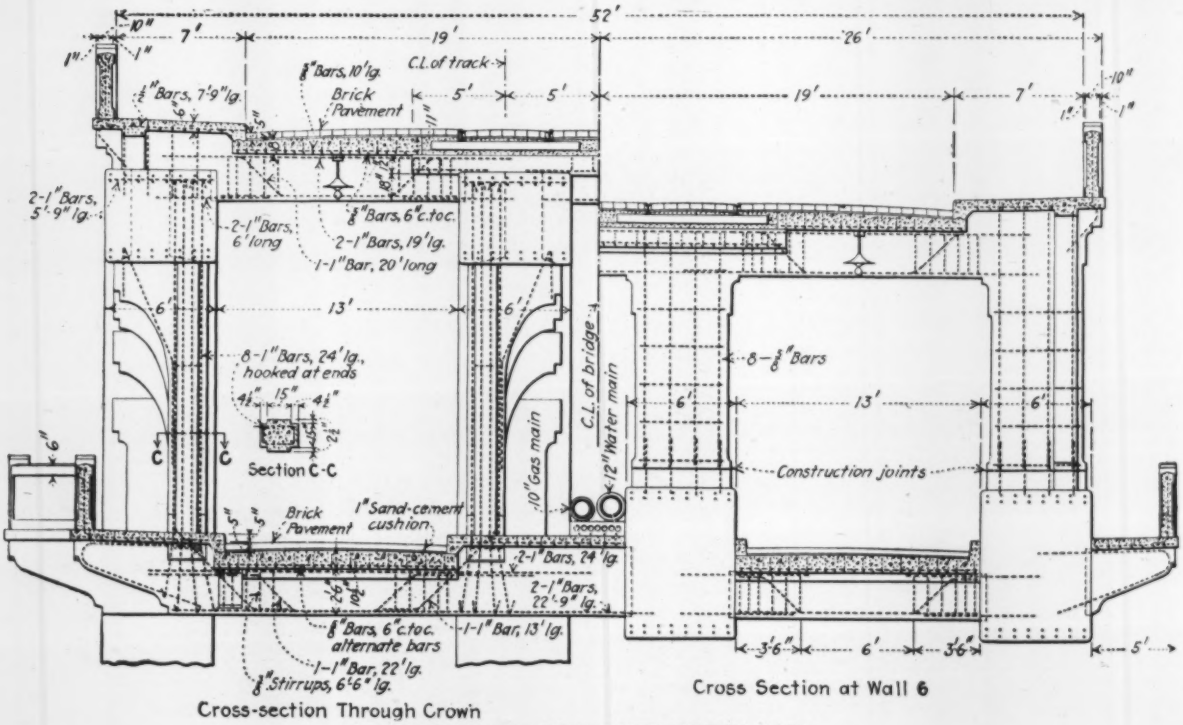


ELEVATION OF THE DOUBLE-DECK ARCH

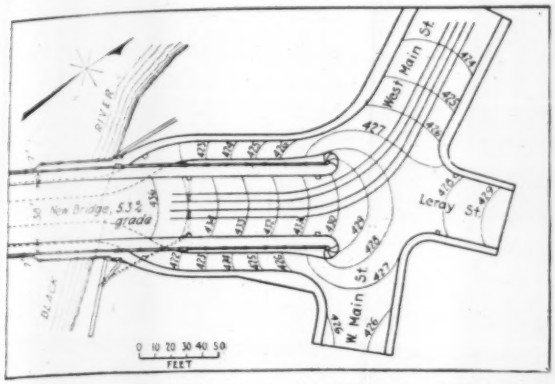
the shape of the arch. The posts were so arranged that they did not interfere with the hanger rods, whose upper ends were concreted into the arch ribs. After the arch had sufficiently hardened to permit the centers to be struck, the upper portion was removed and the formwork for the lower deck was built on the lower portion of the arch falsework. Upon the removal of this falsework, the weight of the lower deck was carried by the rib.

After the hangers were concreted, the contractor was able to proceed with the erection of the walls and girders supporting the upper deck.

Entrances to the lower deck at the south end of the double-deck span and under the continuous girders previously mentioned were readily facilitated and there was plenty of space for all kinds of vehicles coming from Newell and River Streets. The north end of the river span presented a more difficult problem. Here on account of cost and property damages, the designers were cramped for room. Several studies were made before the plan shown was finally evolved and adopted. This figure (on p. 545) is an excellent example of how complicated grade intersections may best be studied by plotting contours. Several examples of the use of



SECTIONS THROUGH DOUBLE-DECK ARCH



METHODS OF LAYING OUT GRADES ON APPROACH

contour lines for solving such problems have been shown in *Engineering News-Record* in the past few years.

Vehicles on the approach grades to the lower deck at the north end pass under a 39-ft. overhead girder which supports the upper deck sidewalk and part of the roadway. The minimum vertical clearance under this girder is 13 ft., while the horizontal clearance was carefully designed for the largest vans now in common use with ample margin for future increase of size.

LOOKING THROUGH THE SOUTH DECK

Each roadway of the lower deck as well as the north approaches to the lower deck is 12 ft. wide between curves except at the above-mentioned underpass where the roadway width increases from 12 ft. to 14 ft., and then decreases to 12 ft. again.

The entire structure, together with the approaches at the north and south ends, was designed by the Concrete-Steel Engineering Co. of New York City, of which William Mueser is sole owner. Mark D. Ewell was resident engineer for the designers. The work was let on a unit price basis to the Peckham Construction Co., Inc., of Buffalo, N. Y., for whom E. C. Boehm was in charge of the work. The city engineer of Watertown is Paul B. Sutton.

The final construction cost of the bridge was $362,000, which was paid by the City of Watertown, the State of New York, and the New York Central & Hudson River R.R., according to schedules agreed upon previous to the letting of the work.

Power Progress on the Saguenay

SAGUENAY RIVER in northeastern Quebec has unusual power possibilities because the total fall from Lake St. John to tidewater, about 320 ft., is concentrated in a distance of 28 miles, and the flow which now ranges from 12,000 to 220,000 sec.-ft. is susceptible of considerable regulation on account of the fact that Lake St. John has an area of over 300 sq.mi., and a drainage area of 30,000 sq.mi. Other power sites in the Saguenay valley are located on the Au Sable and Chicoutimi Rivers, the two outlets of Lake Kenogami. The flow of these two rivers can also be regulated by increasing the storage capacity of Lake Kenogami.

Isle Maligne Power Station—The present development includes the concentration of the power of the Saguenay River in two plants, one located at Isle Maligne, a point on one of the outlets of Lake St. John, called the Grand Discharge, and the other down near tidewater, a few miles above the mouth of the Shipshaw River. Work on the Isle Maligne station, which is to have a capacity of 480,000 hp., was started in January last. Access to this plant required the building of 15 miles of railway including a bridge over both the Little Discharge and one channel of the Grand Discharge.

This development consists of a power house, four spillways, a dam to control the right channel of Grand Discharge at Isle Maligne, one earth dam, and three spillways at the head of the Little Discharge. The power house, which itself is the largest of the dams, will contain twelve 40,000-hp. units.

This work is being carried on by the Quebec Development Co., of which J. B. Duke is president, W. S. Lee and F. A. Cochran, vice-presidents. W. S. Lee is acting as chief engineer and F. A. Cochran as resident manager of the Isle Maligne work.

Chicoutimi Development—Lake Kenogami, at the headwaters of the Chicoutimi River, has a drainage area of 1,450 sq.mi. and a water surface of 12 sq.mi. The present development scheme calls for increasing this storage area to 21 sq.mi. by increasing the level of the lake 32 ft. The lake has two outlets discharging into the Saguenay, one the Chicoutimi River, 15 miles long, with a total fall of 467 ft., and the Au Sable River, 6 miles long, with a drop of 440 ft. Under the proposed storage scheme the minimum dependable flow of 1,800 sec.-ft. will be distributed on the basis of $\frac{3}{4}$ to the Chicoutimi and $\frac{1}{4}$ to the Au Sable. There are already two developments on the Chicoutimi River, one at the town of Chicoutimi, utilizing a head of 56 ft., and another of a head of 190 ft. at the plant of La Cie de Pulpe de Chicoutimi. A further head of 60 ft. is now being developed by Price Bros. On the Au Sable River, Price Bros. have already developed a total head of 380 ft.

The storage work on Lake Kenogami will necessitate the construction of two concrete dams, one at each outlet, and four earth dikes to keep water from the raised lake from overflowing into other watersheds. The construction of these dams and dikes is to be carried by the Quebec Stream Commission, which has been guaranteed a sum sufficient to cover the yearly interest, operating and sinking fund charges by the companies deriving benefit from the additional storage. O. O. Lefebvre is chief engineer of the Quebec Stream Commission.

Indebtedness to the *Journal* of the Engineering Institute of Canada and to H. G. Cochran, A. F. Dyer and C. N. Shanly for this information is acknowledged.

Highway Traffic Surveys in Nine Tennessee Counties

Determine Kind, Volume and Distribution of Traffic and Gross Load and Unit Wheel Loads on Freight Carrying Vehicles

By N. W. Dougherty
Professor of Civil Engineering, University of Tennessee, Knoxville, Tenn.

During the summers of 1921 and 1922 co-operative traffic surveys were conducted in nine Tennessee counties by the Bureau of Public Roads, the Tennessee Highway Department, the University of Tennessee and the several counties. The surveys were planned, first, to determine kind, volume and distribution of travel, and second, to determine capacity and weights of freight vehicles by measuring gross load and unit wheel loads.

Counting stations were established on all the main highways of the several counties. The stations were established at intersections where separate counts could be made on the primary roads and also on the secondary, or feeder roads. Fig. 1 for Knox County illustrates the choice of stations. In this county 64 separate counts were made by placing the counters at 31 counting stations. To obtain weights of vehicles, weighing stations were established on selected roads of each county. Both loaded and empty trucks were weighed in sufficient numbers to give a fair estimate of freight haulage, average load and prevalence of overloading. Two loadometers were used in determining weights.

The traffic counts in the several counties were scheduled over four-day periods, beginning on Thursday and ending on Sunday. On one day of each count automobile and truck license numbers were listed. At many stations the number of vehicles passing was so large that license numbers could not be accurately listed; at such stations the counter recorded the type and direction of vehicles. During the two summers' work

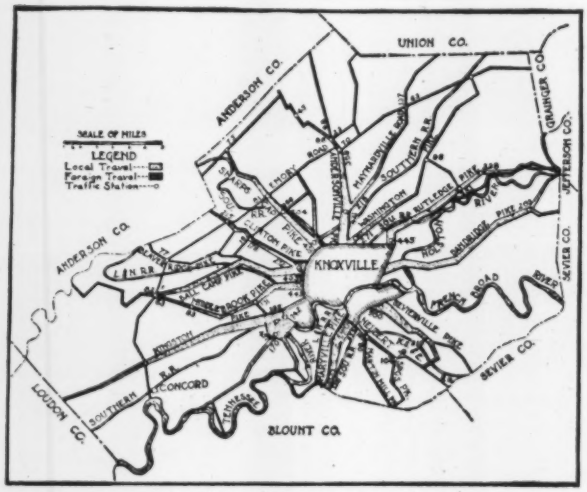


FIG. 1—TRAFFIC MAP OF KNOX COUNTY

more than 28,000 auto-license numbers and 6,900 truck numbers were listed and tabulated. The license numbers were used to determine local and foreign travel.

Kind and Volume of Travel—Traffic information was so listed that analysis could be made of the number of automobiles, trucks, buggies and wagons. A summary for the nine counties, which includes an average daily

FIG. 2—TRUCK HAULAGE OF LIVE-STOCK IS COMMON

number of vehicles passing, of more than 99,000, gives percentages as follows: Automobiles, 69.1, and trucks, 14.0, making a total of 83.1 per cent for motor-drawn travel leaving 16.9 per cent for horse-drawn travel comprising 7.8 per cent buggy and 9.1 per cent wagon.

It will be noted, Table I, that in Hamilton County only 5.5 per cent of the total number of vehicles listed were horse-drawn vehicles. In Madison County the percentage reaches 37.1 for horse-drawn vehicles against

TABLE I—KIND AND VOLUME OF TRAFFIC IN NINE TENNESSEE COUNTIES

County	Total	Autos No.	Autos Per Cent	Trucks No.	Trucks Per Cent	Buggies No.	Buggies Per Cent	Wagons No.	Wagons Per Cent
Cumberland	380	269	70.8	13	3.4	9	2.4	89	23.4
Davidson	23,083	15,575	67.4	3,728	16.2	2,096	9.1	1,684	7.3
Hamblen	3,500	2,322	66.2	373	10.7	314	9.0	491	14.1
Hamilton	21,390	16,787	78.5	3,417	16.0	288	1.3	898	4.2
Knox	11,153	7,614	68.3	1,637	14.7	849	7.6	1,053	9.4
Madison	8,967	4,950	55.2	693	7.7	1,702	19.0	1,622	18.1
Maury	4,017	2,614	65.2	97	2.4	714	17.7	591	14.7
Shelby	25,496	17,610	69.0	3,800	15.0	1,537	6.0	2,550	10.0
Williamson*	1,185	790	66.6	107	9.0	202	17.1	86	7.3
Totals and average per cents	99,171	68,531	69.1	13,865	14.0	7,711	7.8	9,064	9.1

* Nine stations on through roads.

62.9 for motor-driven vehicles. In the four larger counties, Davidson, Hamilton, Knox, and Shelby, the percentages are, autos 71.0, trucks 15.5, buggies 5.9 and wagons 7.6 making 86.5 per cent motor-driven vehicles against 13.5 per cent horse-drawn vehicles. In the five smaller counties the average is, autos, 60.4, trucks 7.1, buggies 16.4 and wagons 16.1 making 67.5 per cent motor-driven vehicles against 32.5 per cent horse-drawn vehicles.

Local and Foreign Travel—In the nine counties over 28,000 automobile license numbers were listed and classified. Table II shows this classification for the county, adjacent counties, other counties of the state and other states. The total for the nine counties gives 78.1 per cent of the automobiles on the road from the county in which the roads were located; an additional 6.8 per cent were from adjacent counties, making the total local travel practically 85 per cent. The number of cars from other states reached only 2.3 per cent of the total.

Table III shows the sources of truck traffic. Here the tabulation is for seven counties with nearly 7,000 trucks. Of all the trucks listed 75 per cent were from the county in which the roads were located. An additional 7.4 per cent were from adjacent counties, making 82.4 per cent of the truck travel purely local. Only 0.5

TABLE II—TRAFFIC CLASSIFIED ACCORDING TO SOURCE (AUTOMOBILES)

County	Total	County No.	County Per Cent	Adjacent Counties No.	Adjacent Counties Per Cent	Other Counties Of State No.	Other Counties Of State Per Cent	Other States No.	Other States Per Cent
Cumberland	289	188	65.0	47	16.3	54	18.7	0	0
Davidson	3,269	2,687	82.3	339	10.3	171	5.2	72	2.2
Hamblen	1,151	769	66.8	118	10.3	225	19.5	39	3.4
Hamilton	7,752	6,258	80.7	78	1.0	1,193	15.4	223	2.9
Knox	7,315	6,322	86.5	504	6.8	364	5.0	125	1.7
Madison	2,832	1,851	65.5	227	8.0	676	23.8	78	2.7
Maury	2,590	2,039	78.7	135	5.2	416	16.1	0	0
Shelby	2,112	1,525	72.3	94	4.4	406	19.2	87	4.1
Williamson*	791	302	38.2	371	46.9	101	12.8	17	2.1
Totals and average percents	28,101	21,941	78.1	1,913	6.8	3,606	12.8	641	2.3

* Through roads.

per cent of the trucks listed were from other states. It will be noted that these trucks were listed in Shelby and Hamilton Counties whose county lines were also state lines. The truck data for Shelby County is not complete or it would show more trucks from Arkansas and Mississippi. In this county the traffic was so heavy that traffic counters could not make accurate lists of the license numbers of all automobiles and trucks passing the roads. Had such a count been made on many of the roads the percentages would run as high as that for adjacent counties.

Weighing Stations—From two to six weighing stations were established in each county. Three stations were chosen on roads where beam scales had been installed and the vehicles to be weighed were passed over the scales. Weights were determined much more quickly by scales than they could be determined by the loadometers. Stations were so selected that typical information could be obtained for each county. The information taken was very complete, giving make and capacity of vehicle, kind and value of commodity, length and direction of haul, frequency and amount of overload, kind and width of tires, and origin and destination of travel. The scope of this paper will only permit a short discussion of two of these items, namely, kinds of commodities and frequency and amount of overloads.

Commodities—Trucks are used to haul a great variety of commodities, varying from such bulk material as logs, sand and gravel to building materials as lathes, lumber and shingles, to household goods, textiles, foodstuffs, soft drinks and finally passengers. The number of separate commodities listed in each county ranges

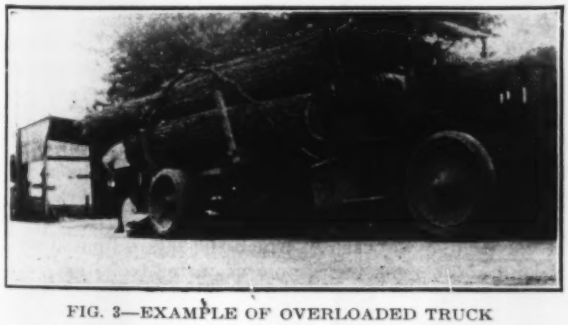


FIG. 3—EXAMPLE OF OVERLOADED TRUCK

from thirty to fifty, depending upon the location of the county, the location of the weighing stations and the number of vehicles weighed. Fig. 2 shows a small truck in Davidson County with sheep. Many trucks in this county and adjacent counties are used to haul live-stock to market at Nashville.

Fig. 1 is plotted to show the average daily twelve-hour travel passing the several traffic stations. The width of line is proportional to the total number of vehicles passing; the dotted width is proportional to the percentage of local automobile travel and the shaded area is proportional to the foreign automobile travel. This diagram and Tables II and III show that the great preponderance of travel is local travel. Simultaneous counts taken over as much as 200 miles of roads show similar information. The road problem, therefore, in Tennessee is essentially a local problem. When the 97.7 per cent of State travel is served the 2.3 per cent of travel from other states will be able to get along.

Overloading—Approximately 55 per cent of the loaded vehicles weighed were carrying loads above their rated capacity. Trucks of all capacities from one-half ton up were overloaded. In some of the counties the overload-

TABLE III—TRAFFIC CLASSIFIED ACCORDING TO SOURCE (MOTOR TRUCKS)

County	Total	County No.	County Per Cent	Adjacent Counties No.	Adjacent Counties Per Cent	Other Counties Of State No.	Other Counties Of State Per Cent	Other States No.	Other States Per Cent
Davidson	772	599	77.5	101	13.2	72	9.3	0	0
Hamblen	352	221	62.7	36	10.4	95	26.9	0	0
Hamilton	2,328	1,743	74.9	25	1.1	526	22.5	34	1.5
Knox	2,105	1,768	84.0	222	10.5	115	5.5	0	0
Madison	500	341	68.2	12	2.4	147	29.4	0	0
Shelby	653	416	63.7	40	6.1	196	30.0	1	0.2
Williamson	176	70	39.8	78	44.3	28	15.9	0	0
Totals and average percents	6,886	5,158	75.0	514	7.4	1,179	17.1	35	0.5

ing for capacities of two tons and over amounted to 68 per cent of the vehicles weighed. Seventy per cent of the vehicles weighed were under two tons capacity while thirty per cent were two tons and over. Of the 30 per cent 19 per cent were of two-ton capacity leaving only 11 per cent for trucks above two tons. The small percentage of vehicles of two tons capacity and above accounts, in part, for the prevalence of overloading for these capacities. Fig. 3 shows a typical heavy load in Knox County. Here a four-ton truck is loaded with logs carrying a gross load of 20,000 lb. and having a concentration of 770 lb. per inch width of tread.

Regulations—The 1921 legislature gave the state highway department authority to regulate traffic on state aid roads and with county co-operation to regulate traffic on the county roads. The regulations issued by the department limit the gross load to 20,000 lb. and the wheel loads to 650 lb. per inch width of tire channel. About 25 per cent of the loaded trucks weighed were violating one or both of these regulations, 23.5 per cent had excessive concentrations on the rear axle and 2.6 per cent had excessive concentrations on the front axle as well. In Shelby County are two pieces of road maintained by the state highway department and in this county the percentage of overloading was considerably lower than in the other counties. On the two roads maintained by the department overloaded vehicles are stopped and required to unload until the regulations are not violated. Enforcement of proper regulations is badly needed in the other counties to protect the roads from the overloading evil.

Canada Spends Ten Million on Roads

Up to Aug. 31, this year, Canada had eighty highway projects totaling 785 mi., costing $9,336,373. Of these, Ontario had fourteen projects totaling 100 mi., and Quebec six projects, totaling 110 mi.

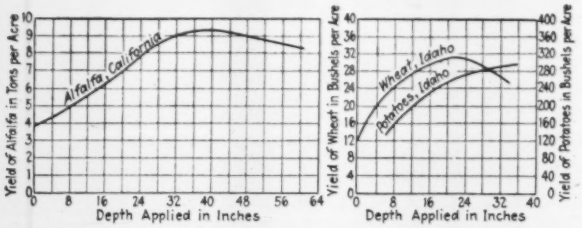
The Economical Use of Irrigation Water Based on Tests

Solution of the Problem Considered When Water Is Available at a Given Price, Land Plentiful, Water Limited and Land Semi-Irrigated

By Harry S. Clyde, Willard Gardner and Orson W. Israelsen
Assistant in Physics Laboratory, Associate Physicist, and Irrigation Engineer, respectively, Utah Agricultural Experimental Station

ONE of the biggest single problems confronting the western public is to determine what amount of irrigation water under different conditions constitutes economical use. During the early settlement of the West there was enough water for all and each irrigator could use the amount he wanted. With the growth of these communities more land has been brought under irrigation and nearly all the late-season water has been appropriated, resulting in a need for limiting the amount of water that each farmer may use to the most economical quantity, in order that the greatest possible irrigation development may be made.

To ascertain what constitutes economical use of water numerous irrigation experiments have been conducted in recent years. Competent engineers, agronomists and others directly interested in irrigation differ widely in their interpretation of these experiments and in the application of them to a determination of what constitutes economical use of water. This paper presents a method of interpreting irrigation experiments under


Yield of Alfalfa in Tons per Acre
Alfalfa, California
Depth Applied in Inches
Yield of Wheat in Bushels per Acre
Wheat, Idaho
Potatoes, Idaho
Depth Applied in Inches
Yield of Potatoes in Bushels per Acre

FIGS. 1A AND 1B—YIELDS AT DIFFERENT WATER APPLICATIONS IN IDAHO AND CALIFORNIA

various conditions of water supply, irrigable land, cost of crop production and value of crops produced. Before the analysis of the problem, some typical experiments in California, Idaho and Utah are briefly reviewed.

Experiments in California—Adams et al.[1] have conducted extensive investigations with alfalfa on the University Farm at Davis, Calif. During 1910 and 1911 a tract of 8.19 acres was divided into checks averaging 0.28 acre each. From 1912 to 1915, inclusive, 3.48 acres were used for this work. The soil was classified by the U. S. Bureau of Soils as a Yolo loam. The annual rainfall during the six years varied from 12 to 24 in. During the first two years the following total amounts of water were given to different plats: none, 12 in., 24 in., 36 in. and 48 in. In 1912 two additional plats were provided which were given depths of 18 and 60 in. A stream of 0.9 sec.-ft. was used to irrigate the plats, and in most cases it was distributed through a slip-joint pipe to insure even distribution. The yield (y-w) curve for this experiment is given above in Fig. 1A. It shows that the maximum yield was obtained with an application of 36 in. of water, although the increase in yield due to increase in depth of water from 30 to 36 in. is almost negligible.

Experiments in Idaho—Bark[2] made investigations to ascertain the water requirements of various crops and soils in southern Idaho. His studies were continued five years over comparatively large areas. At the Gooding Station the average rainfall for the five years was about 11 in., of which 3 in. fell during the growing season. The experiment farm soil is a medium clay loam, rather impervious, and from 6 to 8 ft. deep. Ninety-six plats were planted with spring wheat of the staple varieties during the five years. The y-w curve given for this experiment in Fig. 1B shows the average results. The yield of grain increased as the water applied increased until a depth of from 16 to 22 in. had been applied, after which more water decreased the yield.

In Figure 1B the y-w curve is given also for potatoes at the Gooding Station. Results are available for applications of water ranging up to 36 in. only. Up to this point the curve shows the yields still increasing with increase in water supplied, but the rate of increase was very small.

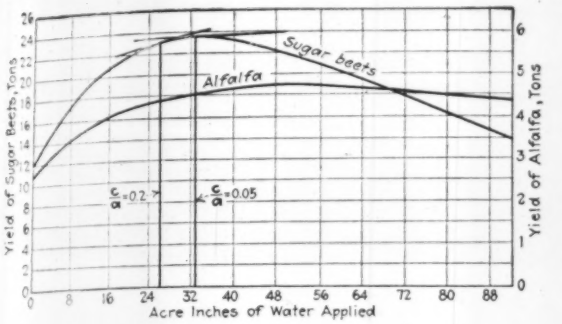
Experiments in Utah—The Utah Experiment Station has done much work on duty-of-water investigations the results of which have been summarized in *Bulletin* 173[3]. The experiments were conducted on a typical, deep, uniform loam having excellent underdrainage. The annual rainfall at the Utah Station varies from 15 to 18 in., of which only about 2 in. comes during the growing season (June, July, and August). The y-w curves for sugar-beets, potatoes, alfalfa and wheat given in Figs. 2 and 3 are the average results of many trials in the Utah experiments.

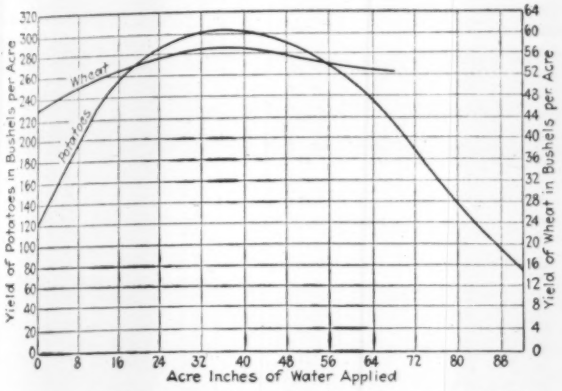
The tests with sugar-beets, which extended from 1902 to 1919, show that the yield increases with applications up to about 30 in. and then starts to decline. There is quite a range where the yield is not greatly affected by smaller or greater amounts of water. The curve for potatoes shows the results of twenty-six trials covering fourteen years. The most favorable amount for potatoes seems to be between 30 and 40 in. Applications above 60 in. make the yield drop fast. The curve for alfalfa shows that it needs more water than other crops, the highest yield being secured with an application of 50 in. The decline in yields from larger applications was very slow. The experiments with wheat show that it is not nearly so much affected by irrigation as are alfalfa, sugar-beets and potatoes. As the applications were increased above 15 in. the yield increased very slowly.

The solution of the problem concerning the economical use of irrigation water rests upon the experimental determination of the y-w curve, examples of which are shown above. With the exception of the various cost data, the y-w curve gives in condensed form all the information necessary for a practical solution of the problem, which has in reality three possible solutions, one for each of three different cases.

Case 1. Water Available at a Given Price—First, let us consider the case in which there is a limited area of land and a sufficient supply of water to be had at a specified price per acre-inch. The question is to determine how much water should be used to secure the maximum profit per acre of land.

Let c = cost of the water per acre-inch, which cost includes the annual interest on money invested in water rights or shares of water stock, the maintenance of the irrigation system and the application of water. It is realized that c, as here defined, is not rigorously constant. A more accurate analysis, considering c as a variable, is presented later in the paper.





FIGS. 2 AND 3—YIELD-WATER CURVES FROM UTAH EXPERIMENTS

w = number of acre-inches applied per acre.
b = cost per acre for plowing, seeding, fertilizing, tilling, taxes, rental value and such other costs as are proportional to the acreage.
a = price per ton of the crop on the farm, which is the market price minus the cost per ton for hauling. The cost of hauling varies with the yield and therefore could not be counted in b.
i = net income per ton.
y = yield in tons per acre.

Then cw = the total cost of the water per acre.

$$\text{And } i = a - \frac{cw + b}{y} \text{ or } iy = ay - cw - b \quad \ldots\ldots (1)$$

Stated in words, this equation means that the net profit per acre equals the total return per acre for the crop at the farm minus the acre cost of the water and the costs per acre for plowing, seeding, fertilizing, tilling, taxes, rental value, etc.

The first derivative of iy with respect to w gives

$$\frac{d(iy)}{dw} = \frac{ady}{dw} - c$$

which is the slope of the curve representing the profit per acre, iy, as a function of w. At the peak of the profit curve, the slope is 0, and if we equate the right-hand member to 0, the derivative of y with respect to w may be obtained.

$$\frac{ady}{dw} - c = 0$$

$$dy/dw = c/a \quad \ldots\ldots (2)$$

This derivative gives the slope of the y-w curve at the value of w corresponding to the peak of the profit curve.

If we follow the y-w curve out until we find a point where the slope of the tangent is equal to c/a, that point gives the w for a maximum profit per acre. To determine the economic w it is only necessary to obtain the y-w curve and determine the ratio c/a. As stated above c is considered fixed. The price per ton or bushel is determined by market prices. Whether a is the price per ton or bushel will depend upon whether the y on the curve is in tons or bushels.

Equation (2) shows that the economical w is independent of the cost of plowing, seeding, fertilizing, etc., because the term b is not contained in the ratio c a, and it is this ratio which determines the economic w. It therefore makes no difference what the price of the land is or how much it costs for plowing, seeding, tilling, taxes, etc., the economic amount of water will be the same. From this solution it may readily be seen that if c is greater than 0, then the peak of the profit curve (iy-w) or the point on the y-w curve where the tangent is equal to c/a will be to the left of the point of maximum yield. This means that where a price is charged for the water the maximum profit per acre will be obtained with some quantity of water less than the amount necessary to obtain the maximum yield.

To illustrate this case, let us consider a sugar-beet farm in Cache Valley. The y-w curve for sugar-beets in this district is given in Fig. 2. The average value of the water right per share in Cache Valley is about $80, which at 7 per cent interest would amount to $5.60 per year. The annual assessments for upkeep of the canals amount to about $1.25 per share. According to Connor,[4] it takes nine hours of man-labor per acre to apply the water and keep the ditches clean. At $0.25 an hour this would amount to $2.25 per acre. Each acre receives approximately 36 in. Using these values the cost per acre-inch would be $0.25 (approximately), which is the value of c for this region. An average price received for the beets is about $5.00 per ton. The value of a is therefore about $5.00 and the ratio of c/a is 25/500, or 0.05, which is the slope of the y-w curve at the economic w. This approaches very closely the w giving the maximum yield.

If the cost of the water were $1 an acre-inch, as it is in some parts of Utah, then the value of c/a would be 100/500, or 0.2. The point where the tangent to the curve has a slope of 0.2 corresponds to 26 acre-inches for w. Clearly the price of the water has a marked influence upon the economical w.

Case 2. Large Area and Limited Water Supply—In many arid region valleys there is insufficient water for the land available and yet irrigation is essential to crop production. Let us consider in Case 2 such arid valleys where land is abundant at a given price but where the water supply is limited. Consider further that it is desirable so to use the limited water supply as to obtain the maximum profit for the entire area. It is clear that in this case a different value of w will be obtained than that under Case 1.

Let w = amount of water per acre in acre-inches.
A = area to be irrigated in acres, which may or may not be the entire area of available land.
Q = total quantity of water available in acre-inches.
P = total profits for the entire area in dollars.
iy = profit per acre in dollars.

Then

$$A = Q/w \text{ and } P = Aiy$$

From which we may write

$$P = \frac{Qiy}{w} \quad \ldots\ldots (3)$$

By differentiating P with respect to w in equation (3), namely, $P = \frac{Qiy}{w}$, we obtain as the first derivative:

$$\frac{dP}{dw} = \frac{Q}{w} \times \left[\frac{d(iy)}{dw} - \frac{iy}{w}\right] \quad \ldots\ldots (3a)$$

At the peak of the total-profits curve (P-w), the slope is 0. Then, equating the derivative to 0 and dividing out the factor Q/w, we obtain

$$\frac{d(iy)}{dw} = \frac{Piy}{w} \quad \ldots\ldots (4)$$

This gives the slope of the profits-per-acre curve (iy-w) at the w giving the greatest profits for the total

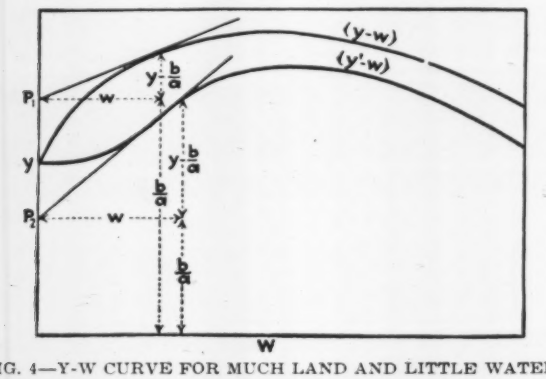


FIG. 4—Y-W CURVE FOR MUCH LAND AND LITTLE WATER

area, but we want the slope of the y-w curve at this economic w.

Expanding equation (4) we obtain

$$\frac{d(iy)}{dw} = \frac{idy}{dw} + \frac{ydi}{dw} = \frac{iy}{w} \quad \ldots\ldots (4a)$$

The derivative of i with respect to w is

$$\frac{di}{dw} = -\left[\frac{yc - (cw + b)\,dy/dw}{y^2}\right]$$

Substituting for i and $\frac{di}{w}$ in equation (4a), cancelling, adding and dividing by a, we obtain

$$\frac{dy}{dw} = \frac{y - b/a}{w} \text{ for maximum } P. \quad \ldots\ldots (5)$$

Equation (5) gives the slope of the y-w curve at the value of w which gives the maximum profits for the total area. That the term c does not appear in equation (5) shows that the price of the water does not influence the amount of water for each acre that will bring the maximum profit for the entire area. However, if the most economical amount of water is used on each acre, then, as the cost of water increases the total profits decrease, and as the water-cost decreases the total profits increase.

Now suppose we have the y-w curve for a given crop in a given locality as indicated in Fig. 4, and we measure off on the y axis a distance equal to b/a. It is obvious that a point on the y-w curve having a slope of $\frac{y - b/a}{w}$ must have a tangent at that point extending through the point P_1 on the y axis marked by the distance b/a. The point P_1 marks this distance for any case where b/a is greater than y when w equals zero. A tangent to the y-w curve through P_1 would then have the required slope, $\frac{y - b/a}{w}$, and the point of tangency would correspond to the economical w. Clearly therefore when b/a marked by any point P_1 is larger than y at the point where w equals zero a line may be drawn through the point P_1 tangent to the y-w curve.

If, however, P_2 is any point in the y axis less than y_0 representing the value of b/a, it can be seen at once that unless there be a point of inflection, as shown in the y'-w curve, a line cannot be drawn through the point tangent to the curve. However, when this condition does arise, as represented by P_2, it means that a profit may be obtained from dry-farming which is contrary to the conditions considered in this case. Such a condition involves other factors which are treated under Case 3.

Should there be a point of inflection on the curve, which is very improbable, a tangent may be drawn through P_2 to the curve as shown on the y'-w curve in Fig. 4, thus showing that a solution would then be possible.

Up to this point the values a, b, and c have been considered as constants, whereas in many cases they are variable and dependent on w. If by chance there should be a scarcity of water over a large area the yield might be decreased to such an extent as to increase the price of the crop. It must be borne in mind, however, that a decrease or increase in yield in one district will not have much effect upon the market price of the crop. The value of b may to some extent be influenced by w, in that w affects the amount of cultivation. Some crops require a cultivation after every irrigation to stir up the soil and prevent excessive evaporation. As more water is applied per acre it may be applied oftener and therefore increase the cost per acre for cultivation.

We may think of the cost of the water, c, as composed of two parts: C_0, the annual charge for construction and maintenance, and C_1, the cost of ditching and application on the farm. The first is known to be a constant as the charge is made equal for every acre-

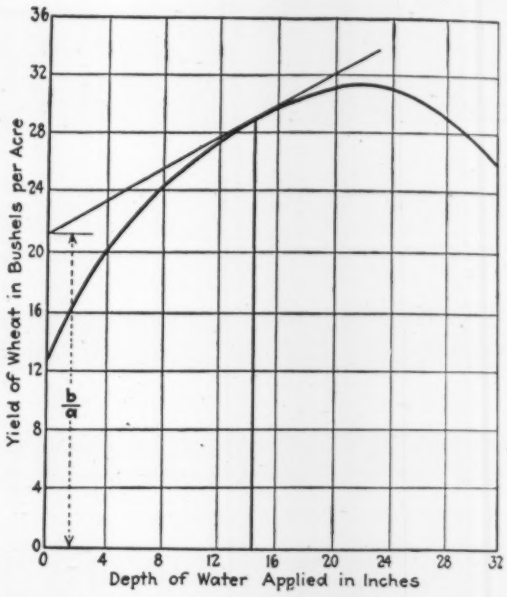


FIG. 5—Y-W CURVE FOR WHEAT IN THE SNAKE RIVER VALLEY

inch. The second depends upon the area irrigated and thus indirectly upon w. The area irrigated depends upon the amount of water used per acre. As the water is spread over more land it requires more ditches and also more attention to spread it evenly. It would require more labor to spread 24 acre-inches over three acres than it would to put it all on the same acre. The value of c is represented approximately by the following equation:

$$c = \frac{C_0 + C_1 A}{Q} \quad \ldots\ldots (6)$$

Where

C_0 = total annual interest and depreciation on the construction cost and the annual maintenance and operation.
C_1 = cost of ditching and application per acre.
A = area irrigated.
Q = total quantity of water in acre-inches.

If these factors a, b and c vary with w, and we substitute in equation (4a) for i its value obtained from equation (1) and for $\frac{di}{dw}$ its value obtained from differentiating i in equation (1) with

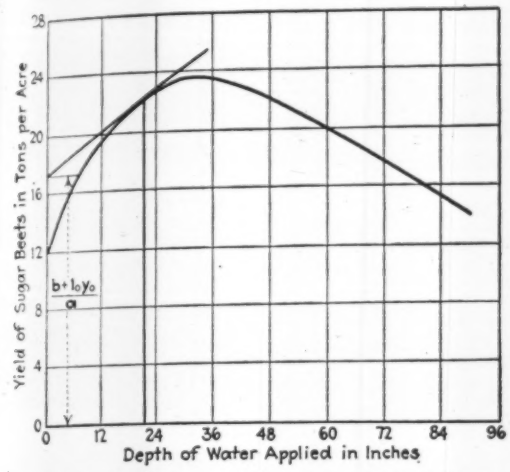


FIG. 6—Y-W CURVE FOR SUGAR BEETS IN CACHE VALLEY

respect to w and simplifying these results, then

$$\frac{dy}{dw} = \frac{y - \dfrac{b + \dfrac{wyda}{dw} - \dfrac{w^2dc}{dw} - \dfrac{wdb}{dw}}{a}}{w} \qquad (7)$$

The value of wdb/dw in equation (7) will always be positive because, as stated above, b gets greater as more water is used per acre which makes the slope of the b-w curve always positive. Also the influence of w upon a is very small and therefore may be disregarded. Under that assumption the term $wyda/dw$ in equation (7) becomes zero. Formula (7) then becomes

$$\frac{dy}{dw} = \frac{y - \dfrac{b + C_1 - \dfrac{wdb}{dw}}{a}}{w} \qquad (7_1)$$

From equation (7_1) it can be seen that increasing C_1 is equivalent to increasing b and thus the economical w is increased. This means that it will pay better to use more water per acre than to spread it over a larger area, which would require more ditches to be built and more labor to apply it.

The Snake River Valley in Idaho presents an interesting example of Case 2. Here there is an abundance of land with a limited supply of water. A large portion of these lands cannot be dry-farmed successfully. The irrigators, irrigation engineers, the water commissioners and the courts are therefore confronted with the typical duty-of-water question, namely, how much land shall the available water be made to irrigate and how much water shall be allowed per acre?

It is recognized that in many parts of the Snake River Valley, and in other similar valleys, water rights have been decreed according to the priority-of-rights doctrine in which economical use as defined under Case 2 is not rigorously required. Nevertheless the analysis is directly applicable in those localities where water-rights are not yet determined and also to readjudications of rights as occasion requires. Moreover it may be applied toward more economical use as between holders of rights to waters recently adjudicated, particularly where the water right is made appurtenant to the land.

In Fig. 5 is given the y-w curve for wheat in this region. To answer the above question for wheat it is only necessary to obtain the values of b and a corresponding to this region, provided of course the y-w curve were fully established.

An approximate average value of the land in the Snake River Valley is $100 an acre. Assuming an interest charge of 7 per cent, this would give a rental cost of $7 an acre. The labor cost of producing an acre of wheat in Cache Valley, Utah, is given by Connor[4] as 29 hours of man labor and 30 hours of horse labor, including the labor used for irrigating. In this paper the labor used in the application of the water has been considered as part of c. Since the yield in the Snake River Valley averages from 20 to 25 bu. an acre and as farming is there conducted on a larger scale than in Cache Valley, thus reducing labor costs, the approximate labor cost for Snake River Valley is assumed to be 20 hours of man labor and 25 hours of horse labor for each acre. An approximate normal value for this labor would be 25c. an hour for man labor and 10c. an hour for horse labor. *Bulletin* 943, published by the U. S. Department of Agriculture (Cooper and Washburn[5]), gives the cost of producing spring wheat for the year 1919. These costs are probably about 50 per cent higher than normal, and this fact has been considered in selecting the values of the various items brought together under the factor b and summarized below:

ESTIMATED COSTS OF PRODUCING ONE ACRE OF WHEAT IN SNAKE RIVER VALLEY, IDAHO, CLASSIFIED AS b COSTS

Use of land or rental value	$7.00
Taxes and insurance	.50
Man labor	5.00
Horse labor	2.50
Seed and seed treatment	2.07
Binder twine	.30
Interest and depreciation on machinery	1.20
Cost of threshing	1.25
Overhead, including minor items	1.30
Total (b costs)	$21.12

A normal price for wheat corresponding to 25c. an hour for man labor is $1 a bushel. This gives the ratio of b/a as 2112/100, or 21.12, which is indicated near the y axis in Fig. 5. A tangent to the curve in Fig. 5 may then be drawn, and the w corresponding to the point of tangency gives the economic w as 14.4 acre-inches for this region. This clearly is only an approximate solution as accurate cost factors for b are not available. However, this illustration serves to show that very accurate solutions may be obtained when the cost factors for b are known and when the y-w curve is fully established.

Case 3. Area Partly Dry-farmed and Partly Irrigated—In many cases the entire acreage in a district is under cultivation, some of it being developed by irrigation and the remainder by dry-farming. Here again the problem arises as to how much water shall be applied per acre on the irrigated part to give the maximum profits for the total area. This case differs from Case 2 in that the land not irrigated may be dry-farmed with profit. In this case $P = P_i + P_o$, where P_i equals the profit from the irrigated section and P_o the profit from the dry-farm area.

For the solution of this case we may take the equation $P = P_i + P_o$ from formulas (3) and (4). Then using the following notation:

i_0 = profit per ton of crop produced without irrigation.
y_0 = yield per acre in tons without irrigation.
i_0y_0 = profit per acre for the dry-farmed area.
t = total area of land in acres.
Q = total quantity of water in acre-inches.

$$P = \frac{Qiy}{w} + i_0y_0(t - Q/w) \qquad (8)$$

Taking the derivative of P with respect to w, equating to zero

and dividing out the factor Q/w and solving for $\frac{d(iy)}{dw}$ gives

$$\frac{d(iy)}{dw} = \frac{iy}{w} - \frac{i_o y_o}{w} \quad (9)$$

which is the slope of the profits-per-acre curve from which

$$\frac{idy}{dw} + \frac{ydi}{dw} = \frac{iy}{w} - \frac{i_o y_o}{w} \quad (9_1)$$

As in case 2, substituting the values of i from equation (1) and di/dw in equation (9_1), cancelling, adding and dividing by a, we obtain

$$\frac{dy}{dw} = \frac{y - \frac{b + i_o y_o}{a}}{w} \quad (10)$$

which is the slope of the y-w curve at the economical w and which differs from equation (5) only by an effective increase in the factor b.

The west part of Cache Valley, Utah, presents an interesting example of Case 3. This land may be dry-farmed at a profit. Recently an irrigation project has been formed to irrigate part of the land and the question arises as to how much land shall be irrigated or how much water shall be applied per acre. To answer this question we must know the profit per acre obtained by dry-farming and we must have the y-w curve for the crop grown on the irrigated land; we must also know the various cost factors outlined under b.

Consider for example that wheat is grown on the dry-farmed part and sugar-beets on the irrigated part. The average yield of wheat on the dry-farm in this district is approximately 26 bu. an acre. The land is worth approximately $65 an acre. One-half of it is summer-fallowed each year. Thus, rent for two years must be charged against each crop. At 7 per cent this amounts to $9.10 per acre. The labor cost includes that on the summer-fallowed part. The costs of producing winter wheat are given in *Bulletin* 943, published by the U. S. Department of Agriculture[5]. These costs were taken for 1919 and are about 50 per cent above the average. This fact has been taken into consideration in selecting the items given below which make up the cost factor classed as b.

ESTIMATED COSTS OF PRODUCING ONE ACRE OF WHEAT IN CACHE VALLEY, UTAH, CLASSIFIED AS b COSTS

Use of land	$9.10
Man labor	4.25
Horse labor	3.35
Cost of seeding and seed	1.45
Binder twine	.30
Threshing	1.50
Use of machinery	1.90
Overhead	1.50
Total (b costs)	$23.35

Considering the average price for wheat corresponding to these costs as $1 a bushel and assuming an average yield of 26 bu. an acre, there would result an average profit of $2.65 an acre, which is the value of $i_o y_o$.

The cost of producing sugar-beets in this district is given by Moorhouse and Nuckols in *Bulletin* 963, published by the U. S. Department of Agriculture[6]. The following values are selected:

ESTIMATED COSTS OF PRODUCING ONE ACRE OF SUGAR-BEETS IN IDAHO AND UTAH, CLASSIFIED AS b COSTS

Use of land	$11.70
Taxes and insurance	.95
Cost of machinery	5.80
Overhead and miscellaneous	5.80
Man labor	25.88
Horse labor	12.00
Contract labor	16.40
Seed	1.35
Manure	3.40
Total (b costs)	$83.28

This gives the value of b as $83.28. An average price for sugar-beets corresponding to these figures is $5 per ton. The ratio $\frac{b + i_o y_o}{a}$ is then $\frac{83.28 + 2.65}{5}$, which equals 17.2. This value of $\frac{b + i_o y_o}{a}$ is indicated near the y axis in Fig. 6. Drawing a line through this point, i.e., 17.2 units above the origin, tangent to the y-w curve, shows the point of tangency as corresponding to a w of 21.5 acre-inches per acre, which is the economical w for this example.

[1]Adams, Frank, et al.: Investigations of the Economical Duty of Water for Alfalfa in Sacramento Valley, California. Univ. of Calif. Publications, Dept. Eng. Bul. 3.

[2]Bark, Don H.: Experiments on the Economical Use of Irrigation Water in Idaho. U. S. D. A. Dept. Bul. 339.

[3]Harris, F. S.: The Duty of Water in Cache Valley, Utah. Utah Exp. Sta. Bul. 173.

[4]Connor, L. G.: Labor Costs and Seasonal Distribution of Labor on Irrigated Crops in Utah. Utah Exp. Sta. Bul. 165.

[5]Cooper, M. R., and Washburn, R. S.: Cost of producing Wheat. U. S. D. A. Dept. Bul. 943.

[6]Moorhouse, L. A., and Nuckols, S. B.: Cost of Producing Sugar-Beets in Utah and Idaho, 1918-19. U. S. D. A. Dept. Bul. 963.

Lessons from a Theater Fire

Stage Portion of Theater Destroyed, but Auditorium Not Damaged—Efficiency of Steel Curtains and Stage Vents

By Dr. E. G. Friedrich
Berlin, Germany

VALUABLE indications of some essential points in theater fire protection were given by a serious fire that destroyed the stage portion of the Wiesbaden Theater last spring. The fire broke out just after the close of a performance of the opera "Rienzi" and destroyed the interior of the stage portion completely, without, however, breaking through into the auditorium.

Very rapid spread of the flames and the development of intense heat characterized the fire. The stage roof, consisting of a zinc covering on wood sheathing on

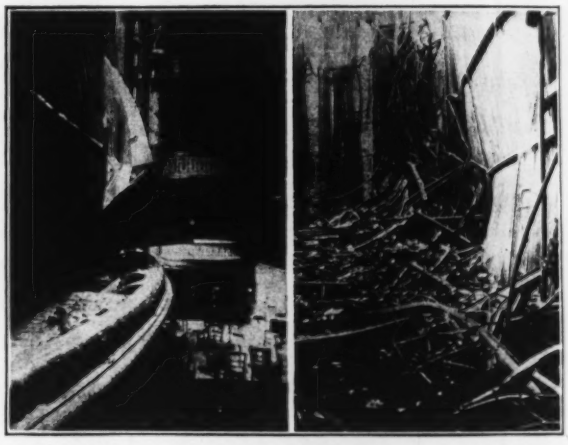


FIG. 1—BULGING OF LIGHT STEEL CURTAIN
Front and Rear Views

unprotected steel trusses, fell a few minutes after the fire department reached the scene. The smoke vents in the roof opened early, under the action of the internal pressure, and gave the fire free vent. Shortly after the fire started, the steel curtain between stage and auditorium, built of corrugated steel with angle-iron stiffening, became incandescent in its middle portion and began to bulge out toward the auditorium. It would have been unable to resist very long but for the relief of the pressure.

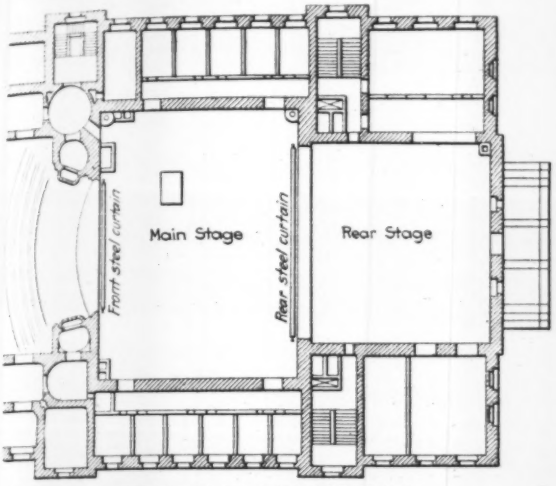


FIG. 2—PLAN OF STAGE SPACE

The roof vents in the stage were formed by swinging sections in the sides of a roof monitor, each swinging section being about 24 in. wide, pivoted on its horizontal center line, and weighted so as to open when the closing rope was released or burned through.

Because of the rapid destruction of the stage portion and the narrow margin by which the auditorium was saved (in view of the incipient failure of the curtain), two points have been under discussion since the fire: How the separation of stage and auditorium is to be made effective under all conditions, and how the stage space itself is to be protected.

Separation of Auditorium from Stage—It is a first principle of theater protection that a fire on the stage must be limited to the stage. This can be accomplished only by a really effective steel curtain provided with substantial stiffening and capable of resisting both intense heat and a certain amount of pressure. The Wiesbaden fire demonstrated that a curtain of corrugated steel with a few angles to stiffen it is wholly inadequate. Stronger construction is necessary. Rapid heating of the curtain should be prevented, so far as possible, and for this purpose it might be advisable to line it on the stage side with oak lagging, which would retard the transmission of the heat from the fire to the steel and serve effectively as a short-time fireproofing of the curtain.

Automatic-sprinkler protection of the curtain is also necessary, but it must be so arranged as to be itself not exposed to derangement by a fire on the stage or by mechanical actions. The Wiesbaden Theater had such a water curtain, but it was of a primitive kind, consisting of a perforated trough above the curtain on the stage side, supplied by pipes running along the stage wall and thus exposed to rapid destruction. The sprinkler piping should unquestionably be embedded in the wall or else placed on the auditorium side; both automatic and manual operation of the sprinkler system should be provided for.

Careful attention should be given also to the construction of the curtain guides. The guides must be of fireproof construction, preferably of concrete, and must be so detailed that there is no chance of the curtain canting or jamming while it is being lowered.

No openings between stage and auditorium other than the opening protected by the curtain should be permitted. Even small openings for ventilation pipes or the like may prove dangerous. All existing doors and openings in present theaters should be closed or equipped with fireproof vestibule construction.

Operation of the curtain should automatically light up the auditorium. Emergency lighting is not likely to prove sufficient in case of outbreak of fire during a performance.

Stage Protection—Provision of sprinkler protection for the stage space itself (apart from the curtain water spray) is eminently desirable. The Wiesbaden Theater had no such sprinkler protection, but its merits were excellently proved in a theater fire in Hamburg years ago.

Divergent views have been expressed since the fire concerning the roof construction and venting of the stage. On the one hand it is claimed that the roof construction should be as light and combustible as possible, and that the roof vents should be greatly increased in area over present practice and should be actuated automatically by a moderate rise in temperature, so that venting of any fire will occur at the earliest possible period and the protection of the auditorium will thereby be rendered more certain. Others hold that the roof should be of completely fireproof construction, that thermostatic smoke vents are unnecessary and objectionable; and that pressure-relief openings, in conjunction with a curtain of adequate strength, are sufficient and would enable the fire to be held in check so that the stage could be saved except in extreme cases.

Doubtless the true solution lies between these two extremes. That smoke vents are necessary can hardly be questioned. Present requirements of building ordinances, which demand a vent area of 12 per cent of the ground plan of the stage, are believed to assure a sufficient vent capacity, but it is questionable whether they should be operated automatically by temperature rise. The initial spread of a fire on a stage, because of the large amount of combustible material and of dust, is exceedingly rapid, and if at a very early stage the draft were increased by automatic opening of roof vents the fire would at once become uncontrollable and it would be doubtful whether actors and the stage force could save themselves. Manual operation should therefore be provided, as well as operation by internal pressure.

Fireproof roof construction is believed to be essential, for proper safety of the occupants of the stage. Nothing will be gained for the safety of the auditorium by facilitating the collapse of the stage roof in a fire.

Operation and Maintenance—Several auxiliary points of caution are brought out by the Wiesbaden fire. The origin of the fire is believed to have been due to alcohol torches which the action of the opera required to be thrown down from a tower on the stage. Through carelessness, presumably, one of these torches was not entirely extinguished. With present-day electrical facilities there should no longer be need for open fire in any stage effect. Combustible or explosive liquids, open fires, and smoking should be banned entirely from the modern stage.

Stage floor spaces must be kept open. Scenery and properties should not be allowed to encumber the stage.

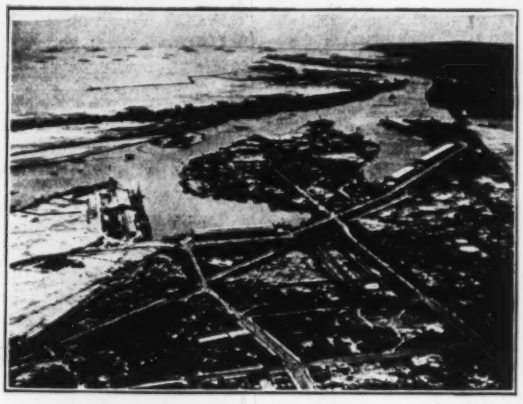
Fire department supervision should not end with the close of a performance but should continue until all spectators have left the theater and a complete inspection of the premises has been carried through.

Los Angeles—The Wonder City of America

By T. A. Rickard
Contributing Editor, *Engineering and Mining Journal-Press*, San Francisco

LOS ANGELES is the wonder city of the country. Its growth has been phenomenal. Its building activity has never known a drop since the war and is increasing remarkably.

To those who have not been there, the tales from Los Angeles seem to be nothing but promoters' talk. But this is not so. Los Angeles, even five years ago, had the earmarks of a boom town, but it has matured at an astonishing rate. Today it is a great industrial city. Around it and in it are three important industries, agriculture, oil and the movies. With these as a basis, Los Angeles has been building industries for supplying food, clothing and housing for its citizens, so that more and more it is becoming self contained. It grows on its own needs.



AIRPLANE VIEW OF LOS ANGELES HARBOR

It was because of the unusual record of Los Angeles and because the work of the civil engineer and contractor follows upon such broad developments as are in progress there that *Engineering News-Record* asked T. A. Rickard, formerly editor and publisher of *Mining and Scientific Press*, and now contributing editor of *Engineering and Mining Journal-Press*, to tell the economic story of Los Angeles.—*Editor.*

LOS ANGELES was founded on September 4, 1781, under the romantic name of *Nuestra Señora Reina de Los Angeles*, Our Lady the Queen of the Angels—but that was long before Hollywood! The first settlement was based upon a grant of land given by the King of Spain to twelve soldiers, all veterans of European wars. The founding of the pueblo was honored by the presence of the military governor, Don Felipe de Neve, and a group of padres from the neighboring mission of San Gabriel. That mission, started ten years earlier by the famous Franciscan friar, Junipera Serra, was the priestly sponsor of Los Angeles, which thereby is linked with the very beginning of Spanish settlement in Alta California. The spot where the Spanish flag was hoisted and the pueblo established 142 years ago is on the northern edge of the old plaza, recently selected as the station for a new union railroad terminal. At that time the site of the present city was on the bank of a small stream, whose fringe of verdure threaded a sunburnt valley. It was an arid land, save in the short rainy season, when for a few weeks it rejoiced in habiliments of tender green and short-lived flowers; during the rest of the year the dust-clouds of the desert danced unhindered over the coastal plain.

The Spanish pioneers were picturesque but idle; the pueblo was of no consequence; it languished, it stagnated, until the early part of the 19th century, when the Mexican revolution provoked a series of internal wars among the Spanish Californians, who resented dictation from Mexico and fought among themselves for control. When Juan Alvarado became governor in 1837 only 150 foreigners were resident in California. The influx of immigrants began soon afterward, and grew to a mighty flood when the cry of "gold" in 1848 lured the adventurous in every land to the hills of California. That immigration synchronized with the finish of the Mexican war and the cession of California to the United States by the treaty of Guadalupe Hidalgo, which was signed on Feb. 2, 1848, nine days after Marshall had found the nuggets at Coloma. This discovery of gold made San Francisco the metropolis of California. Seven years earlier the precious metal had been mined in the San Fernando hills behind Los Angeles and profitable operations had attracted prospectors thither from Mexico. Even earlier finds are known to have been made in southern California during the Mexican régime, but they attracted little notice because the *haciendados* deprecated anything that might take the laborer from their fields and gardens. But although Los Angeles failed to become a gold-mining center, she takes tribute today from a mineral industry—oil—vastly more profitable than the placer diggings that drew the world's wondering eyes upon California.

While the people of northern California were rejoicing in their golden dreams, those in the south turned their attention to the humdrum business of raising cattle. For a decade Los Angeles took rank as the "Queen of the Cow Counties". That may sound unromantic as compared with *Nuestra Señora Reina de Los Angeles*, but it denotes the making of money. The large land-holdings that had survived from the Spanish dominion favored this industry; but, in the transition from Mexican to American control the titles to the old ranches were thrown into confusion by squatters; and on top of these misfortunes came a series of droughts culminating in that of 1864, which ruined the *rancheros*. The result was to change the economic life of Los Angeles, by introducing a diversified agriculture upon the small holdings into which the old estates were cut. At first grapes and wheat were the chief products. The citrus industry began in 1873; the oil industry in 1892; the moving-picture industry in 1908. In all of these Los Angeles today ranks supreme. Astonishing as has been the growth of this community during the life of our generation, its statistical record for the first four months of the current year has been even more remarkable.

The Harbor—The port of Los Angeles was known as San Pedro until 1909, when it was embraced by the city limits. There are some who have laughed at the pride of Los Angeles in her maritime approach, but he laughs best who laughs last, and in this case it is Señor Angeleno. The wharves are 20 miles from the center of the city, but the time is not far distant when the entire inter-

mediate space will be covered with homes and gardens, factories and warehouses. The harbor itself consists of an estuary protected by a breakwater. In 1922 Los Angeles imported more lumber than any other seaport in the world, namely, 1,440,000,000 board feet. This indicates an enormous activity in building operations; in which respect for three years Los Angeles has been exceeded only by New York and Chicago. It is expected that the building permits in Los Angeles for 1923 will be $200,000,000. In March, 1921, the building permits totaled $6,915,216; in March, 1922, $10,964,829; in March, 1923, $21,196,087.

The incoming traveler is given another hint of big business by noting a steamer, or tanker, that is being loaded with oil at a neighboring wharf. Los Angeles is today the biggest oil-producing center in the world, and much of her oil is being exported through the Panama Canal to the Atlantic and Gulf ports: during the first quarter of 1923 such shipment was no less than 1,143,000 tons. In April a single tanker carried 4,200,000 gal. of gasoline in bulk from Los Angeles to London.

In intercoastal trade the port of Los Angeles ranks second in the United States. During the last three months of 1922, according to the Shipping Board, the coastwise trade of Los Angeles was 2,401,464 tons, and the foreign shipping 251,963, a total of 3,171,629 tons in those three months. During the first quarter of 1923 Los Angeles did a business greater than all the other Pacific Coast ports and more than half all the intercoastal business of the United States; its "in" and "out" tonnage was 1,410,533, which included an incoming tonnage of 300,000. Foreign shipments have increased from 10½ to 23½ per cent during the past year. In 1921 the commerce through the port was 4,850,000 tons; in 1922 it was 10,800,000 tons. Evidently the arid eloquence of statistics is on the side of the Angeleno when anybody sneers at his claim to having a great seaport.

The Inhabitants—The streets are congested with motor traffic, the sidewalks are crowded with people, the benches in the parks are occupied all day, and the hotels are overflowing. This suggests a large and growing population. Statistics tell the story:

Year	Population	Year	Population
1781	44	1890	50,395
1800	315	1900	102,479
1850	1,610	1910	319,198
1870	5,614	1920	576,673
1880	11,183		

Evidently such a growth is too fast for accurate enumeration; any census is soon out of date. In May the population of Los Angeles was 800,000. I noticed a poster "Los Angeles—A Million—1925", and when I spoke of it to the statistician of the Chamber of Commerce, he exclaimed: "Oh, we'll be a million long before 1925". I asked: "How long?" "In 1924", he replied. Evidently they measure time not by the swing of the pendulum but by heart beats.

It is the boast of Los Angeles that it is 70 per cent Anglo-Saxon; it is peopled by men and women of the old stock, by the descendants of those who left the New England and Southern States to open up what was then the West and is now the Middle West. The census of 1920 gave Los Angeles a population of 576,673, of whom 454,542 were native-born. Of these 116,116 were born in California; the Middle West (12 States) contributed 181,835; the South contributed 52,329; New York gave 50,548, and Pennsylvania 19,457. Of the Mountain States the largest complement, 8,979, came from Colorado. Los Angeles has 50,000 Mexicans, who do most of the common labor. No other large city in the United States has so small a proportion of aliens.

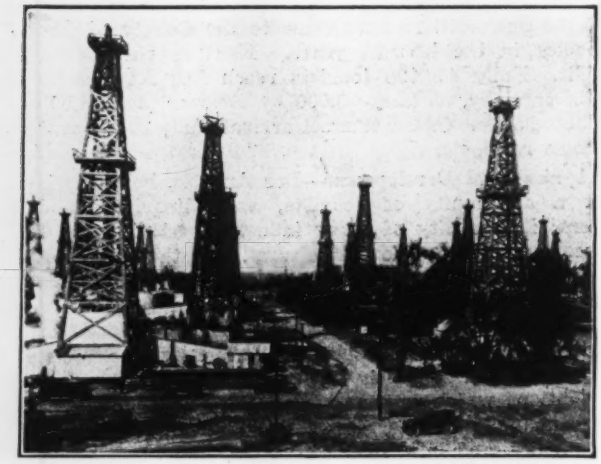
The growth of Los Angeles is the romance of the Middle West; it represents the migration of home-seekers from the prairies and mountains to the orange groves and rose gardens. Again let statistics tell the tale. New settlers are arriving at the rate of over 10,000 per month, say 130,000 per annum. These bring an average bank account of $700, making $91,000,000 in a year. To these deposits are added further sums as the new residents transfer investments from their former habitats to Los Angeles. It is estimated that 250,000 new settlers have come to the County of Los Angeles in the last 2½ years. Next is the tourist traffic. Fully 400,000 tourists reach Los Angeles by train annually, at least 50,000 by steamer, and 75,000 by automobile. Of the summer arrivals fully 20 per cent become residents.

Agricultural Development—Los Angeles, however, is not a community of tourists, valetudinarians, and idlers; it is a city of many industrial activities. Of these the oldest is the agricultural. On the surrounding plains where fifty years ago gaunt herds of cattle scraped a bare existence from the hard soil, where starving sheep wandered disconsolate amid clouds of dust, today is one of the pleasure gardens of the world. This arid land has been touched by the fairy wand of irrigation, which has first made use of the subterranean supply of water, tapped by wells and distributed by ditches, and later of the water brought on a large scale from distant fountains. The city covers an area of 370 square miles; the county, 4,076 square miles, of which not quite half is on the seaward side of the coast range, the country north of the mountains being of desert character. The county of Los Angeles is the most productive county in the United States, and it has enjoyed that distinction for more than a decade. In 1919 the total value of its agricultural output was $61,864,479. The second county in productivity was Fresno, in California, with $52,541,205, and the third, Aroostook, in Maine, with $51,861,252. In 1920 the orange crop was worth $18,965,800, which may be compared with the gold production of the State of California in that year, namely $17,398,200. The golden fruit of Los Angeles was worth more than all the golden ore of the leading gold-producing state. In 1922 the orange crop suffered from an unusual frost, but a high price mitigated the disaster, so that the total production of crops was worth $59,680,183 the principal items being:

Oranges	$17,841,542	Lettuce	$2,500,000
Lemons	3,748,000	Beans	2,284,800
Walnuts	3,412,800	Sugar beets	1,932,984
Alfalfa	3,388,000	Grapes	1,735,500
Strawberries	3,310,790	Potatoes	1,663,500

Oil Resources—Within four blocks of the center of the city oil is still being pumped from a number of old wells. This is the Salt Lake oil field, discovered by miners from Salt Lake City in 1892. Here Edward L. Doheny made his start as an oil-operator. In 1894 these wells produced 196,094 bbl. of oil; but that was a mere bagatelle. The industry has grown enormously during the last three years. In 1920 the oil fields of the Los

Angeles area, including the counties of Los Angeles and Orange, yielded 30,005,427 bbl.; in 1921, 35,587,492 bbl.; in 1922, 68,344,308 bbl., or just one-half of the total production of California, which was 138,236,490 bbl. The oil produced in the Los Angeles area during 1922 was worth $96,000,000. The three principal oil fields tributary to Los Angeles (Santa Fe Springs, Long Beach (Signal Hill), and Huntington Beach) have developed greatly. Between Jan. 1, 1922, and 1923, the number of wells at Santa Fe Springs increased from 3 to 145 and their yield from 3,000 to 203,000 bbl. per day. The increase at Long Beach was from 5 to 237 wells, production from 1,100 to 144,000 bbl. At Huntington Beach there were 71 wells at the beginning of 1922 producing 13,800 bbl. per day; sixteen months later this oil field



THE OIL FIELDS OF SANTA FE SPRINGS

had 248 wells yielding 113,915 bbl. per diem. On May 1, 1923, these three oil fields were producing 460,915 bbl. daily, or more than two-thirds of the output of the whole of California. In 1921 the average daily production of the entire State was only 314,657 bbl.

The activities of the oil promoter sometimes conflict with those of the dealer in real-estate, but usually they supplement one another amicably. A realtor's sign says: "Mining rights included". That means that a man can buy a tract of land on which crops are growing and retain the ownership of any oil that may be stored in the sand several thousand feet underground; he can speculate both on the surficial agricultural products and on the subterranean mineral deposit.

Industrial Development—A community that is growing fast creates the need for new industries; it also becomes rich enough to start industries that will serve the surrounding region. The bank deposits of Los Angeles were $284,940,000 on June 30, 1917; they were $620,095,000 on June 30, 1922. In 1900 the products manufactured in Los Angeles were valued at $15,134,000; in 1922 their value was $900,000,000. Conditions are highly favorable to manufacturing on a big scale. The costs of power and water are low.

The climate permits outdoor work the year round. Conditions are such as to attract the best type of workman. Labor troubles are infrequent. Strikes are non-existent, because Los Angeles is an open-shop center. The labor-unions have nicknamed it the 'scab' city, and its citizens accept that opprobrious epithet as a compliment. It means liberty under the law. The last eruption of anarchy was in 1909, when the office of the *Los Angeles Times* was wrecked by bombs; the perpetrators of the crime are in prison. That affair outraged public opinion so thoroughly that the truculence of the unions was checked effectively.

In 1910 Los Angeles was the 37th industrial city in the United States; today it is seventh. It employs 130,000 artisans. The leadership of the community is in the hands of a group of men with the ability to take advantage of the remarkable natural resources of Los Angeles, and sufficiently big-minded to work together harmoniously for what they deem to be the common interest. For example, in 1920 the market for cotton collapsed just when the crops of the Imperial valley (in California and Mexico) and the Salt River valley (in Arizona) were ready for sale. The producers faced the loss of a market for a crop that had been grown during a period of high cost, involving most of their capital, which was the working capital of a territory new economically. If they did not receive financial aid at this critical juncture, at the end of 1920, the people in these two great valleys would become bankrupt, and with their bankruptcy would go the capital accumulated in twenty years. Thereupon the Los Angeles bankers joined in extending a loan of $5,000,000 to the banks in the two cotton-growing districts, this loan being secured by the cotton, which could not then be liquidated. Instead the Los Angeles bankers imported experienced men from other cotton regions (in Texas and the South) and developed contacts with cotton buyers; they opened a market for the cotton, and eventually moved the entire crop at a price that sufficed to repay the loan and yet leave something for the producers, who are now in process of recovering their prosperity. The result is that the people of the two cotton districts are bound by ties of friendship to Los Angeles, which is accepted as their metropolis.

Los Angeles is establishing good relations with the mining districts of the Southwest. The people of western Arizona, southern Nevada, southwestern Utah, and northwestern Mexico are being taught to look upon Los Angeles as their metropolis, as the source of capital, as the market for supplies, as the resort for a holiday. For those living in the Pacific Southwest, the harbor of Los Angeles is becoming recognized as the "front door", through which their products can be moved to market most economically. Los Angeles money is going forth into the central valleys of California and is helping to finance projects much farther afield, in Utah, Nevada, Arizona, New Mexico, and northern Mexico. Communication with the southern counties of California is facilitated by a fine system of paved roads, of which these 14 counties have 3,105 miles, besides 30,924 miles of secondary roads.

Climate—The climate of Los Angeles is one of its attractions. Meteorological records for 47 years show that Los Angeles has an annual average of only 11 days without sun, and only 15 days with as much as a quarter of an inch of rain; it can claim 273 days when the temperature is neither above 80 deg. F. nor below 40 deg. The rainfall averages only 15 inches per annum and is concentrated into a period of 40 days. The result of these favorable conditions is that Los Angeles enjoys a vigorous semi-tropical climate with all varieties of healthful weather.

The Movies—Hollywood is not a suburb of Los An-

geles; it is an integral part of the city, although its outer edge spreads among the hills, where the more notorious cinema actors have built their villas. Disreputable or not as some of them may be, they contribute to the wealth of Los Angeles. The weekly payroll of the local cinema industry is $500,000 and the capital invested in the business is said to exceed $20,000,000. Los Angeles produces 85 per cent of the motion pictures made in the United States. Fifty-three studios, employing 200 companies, with 15,000 regular employees and 20,000 extra helpers are producing films valued at $170,000,000 per annum. The actors represent only 10 per cent of those employed in this business. The cost of a seven-reel picture ranges from $100,000 to $250,000. Most of this output is financed in Los Angeles.

Public Utilities—Such a community—growing by leaps and bounds—calls for the rapid development of public utilities on a large scale. Los Angeles suffers from growing pains: the sewers periodically prove inadequate, it is impracticable to install telephones as fast as they are wanted, the extension of the street-car system lags far behind the requirements, the schools are overcrowded, but in one respect the city has made ample provision; it has a superb supply of good water.

First, let us look at the telephone system. Los Angeles has 22.7 telephones per 100 of population, as against 4.7 per 100 in London, and an average of 12.5 telephones per 100 in the whole United States.

Second, an abundant supply of good water is essential to a large community; in this respect the men of Los Angeles showed keen foresight. They have water enough to supply a city of 2½ million people. The building of the water conduit from the Owens river across 250 miles of rugged desolate country to Los Angeles is one of the romances of public utility. The engineer who designed it—William Mulholland—fulfilled his promise to do the work in five years at a cost of $23,000,000. In 1905 a report made for the Water Commissioners showed that nowhere in the basin south of the Tehachapi range and west of San Bernardino could an adequate supply of water be obtained for the city without interfering with the welfare of the adjacent agricultural territory. The former source of supply, the Los Angeles river, would have restricted the population to 300,000. Fred Eaton, formerly city engineer and mayor, was familiar with Inyo county and had seen the splendid stream of water that the Owens river carried from the watershed of the Sierra Nevada into the desert, where it was lost in a dead sea of saturated salt solution. To take this water would rob nobody. He bided his time, he bought lands for the purpose, he acquired options, he was prepared for a private enterprise if the city should hesitate to tackle the project. In 1907 the people of Los Angeles voted $23,000,000 of bonds to finance the project. The vote was in the ratio of ten to one.

Five generating plants along the aqueduct develop 110,000 hp. Another 110 hp. is generated from streams tributary to the aqueduct. The total hydro-electric power resources owned by Los Angeles in connection with its aqueduct amount to 220,000 net horsepower. The city is distributing 90,000 hp. from its aqueduct system, at a cost to itself of 0.4c. per kilowatt-hour, and 25,000 hp. more that it purchases from the California Edison Co. Domestic lighting costs 5.6c. per kilowatt-hour for the first 100 kw.-hr., and 4.1c. for the next 500 kw.-hr. For manufacturing purposes a rate of 1.06c. per kilowatt-hour for 100,000 kw.-hr., and of 0.86c. for 1,000,000 kw.-hr. is maintained.

Here, too, it is proper to mention the enterprise of the Southern California Edison Co., which is engaged in a project to develop 1,400,000 hp. on the south fork of the San Joaquin river at an expense of $300,000,000. This power is to be transmitted at the unprecedented pressure of 220,000 volts. In 1923 this company will expend $26,000,000, as against a budget of $50,000 in 1900, when its generating capacity was only 12,000 hp. as compared with 500,000 hp. today. This company has 48,108 stockholders.

Real Estate Promotion—The increase of population explains the tremendous activity in house-building and the hectic condition of the real-estate market. Los Angeles has had many such booms, all of which have run their course to an exuberance that brought its own natural corrective in a temporary collapse; nevertheless the dreams of the realtor of yesterday have become the actualities of the householder of today. At the present time the property assessment of Los Angeles county is $1,517,000,000, which is one-third that of all California. During the year ending March 5, 1923, there were erected 102,000 new buildings in Los Angeles.

As I strolled downtown from the University Club, I was asked by a pleasant voiced young woman to join an "excursion de luxe to Verdugo Woodlands", which was described as "the California Switzerland with its memories of Spain". To help the Iberian illusion, I was informed, on a handbill, that "a dainty Spanish luncheon will be served, while the breezes, whispering through the old rose vines will tell you of the historic happenings of a bygone century". The realty agent and the oil promoter adopt similar methods for beguiling the unwary. The visitor to Los Angeles is invited to a "free ride" in a handsome motor-bus to see some lovely lots in a new subdivision or to consider the purchase of attractive stock in an oil company. He hears a lecture on oil or oranges or the climate of Los Angeles from a person of the preacher type, a spellbinder to whom the promoters pay a fabulous salary, comparable with that of a 'movie' actor. The supposition that the average man grasps at something for nothing is based on good psychology, likewise the anticipation that he will be lured by the chance of making ten dollars by risking one.

Labor Conditions—Labor is being attracted to Los Angeles by the prevailing high wages. This may explain the shortage of workers at the mines of the Southwest. As I walked along the street I heard a warning: "Look out below". A man was throwing remnants of construction over a fence. The phrase he used told me that he was a miner, so I asked him where he had been working: At Jerome, in the U.V.X., he said. Even the high wages paid by James Douglas in such a rich copper mine as the United Verde Extension did not suffice to keep him in Arizona. Can you wonder? Who would not prefer to work in the sunlight, so near the seashore and the orange groves, rather than labor in the dirt and darkness underground? They come to their work in automobiles. Almost anywhere in the outskirts of the city one can see a string of cars lined up like a funeral, the cars belonging to those at work on a nearby building. Thanks to Henry Ford, the

workman can live anywhere within 15 miles of his job; when off work he can cruise about the adjoining country, and acquire the desire for better ways of living.

Yes, there are many automobiles in Los Angeles. One of the Angelenos carries the license of No. 1,000,000. That is a gasconade; it does not mean that a million licenses have been issued by the State Motor Vehicle Department, which distributes its licenses in serial groups for local distribution; however, in 1922 Los Angeles county had 275,000 out of the 840,000 motor vehicles in California. The city itself had 200,000 automobiles, or nearly a quarter of those in the State.

Her Citizens—While Los Angeles has been exploited by advertising on an extraordinary scale, it is also the product of the co-ordinated energies of good citizens. Its Chamber of Commerce today has 9,400 members, which is more than any other Chamber of Commerce in the world. In them there is "some genius of authentic love for their neighborhood, their city". They are men of the old stock; their names are easy to pronounce; they represent the diverse activities of the community. I venture to name some of them. Among the bankers: Henry M. Robinson, Joseph F. Sartori and Henry S. McKee; among the business men: Henry E. Halderman, John B. Miller, Lee Phillips, and the late Arthur Letts; among the engineers: William Mulholland, J. B. Lippincott, and Seeley W. Mudd; among the lawyers: Marshall Stimson, George A. Farrand, and Louis Hill; a publisher, Harry Chandler; a physician, John R. Haynes; an educator, Susan Dorsey, and two benefactors of great wealth, Henry E. Huntington and Norman Bridge. The gift of the Huntington library, picture gallery, and botanical garden at San Marino is an event in the cultural life not of Los Angeles alone but of California. Similarly the endowment of the California Institute of Technology at Pasadena by Dr. Norman Bridge and Arthur H. Fleming has established a center of scientific research for all California, under the leadership of Dr. Robert A. Milliken.

Man does not live by bread alone, neither on oil, nor even on oranges; the leaders of Los Angeles are awake to the fact that if their community is to hold its proper place it must provide for more than the material needs of its people, it must not count only on its tons of oranges or its barrels of oil, but on the great imponderables that make men worthy citizens of a democratic commonwealth.

Four Years Enough to Complete Hetch Hetchy

M. M. O'Shaughnessy, city engineer of San Francisco, recently made an official statement as follows: "It will take from thirty to thirty-two million dollars to build the Hetch Hetchy aqueduct from Moccasin Creek to Irvington. There are no physical obstacles in the way. If the money is provided this work can be done inside of four years and would make Hetch Hetchy water available for use not only in San Francisco, but in other bay cities." Moccasin Creek, the location of the first Hetch Hetchy system power house, is the point to which water can be delivered through works now practically complete. Irvington is about 100 miles toward San Francisco from Moccasin Creek and it is here that the aqueduct begins which is now being built for the use of the Spring Valley system until Hetch Hetchy water is available. Reference to the construction of this aqueduct from Irvington to the city appeared in *Engineering News-Record*, May 4, 1922, p. 751.

Leveling Morro do Castello in Rio de Janeiro

Fifty-Acre Hill in Brazilian City Being Cut Down and Used to Make an Extensive Fill on the Water Front

ONE of the largest city grading operations of recent years is in progress at Rio de Janeiro. The Morro do Castello, having a volume of some 5,000,000 cu.m., is being leveled and the excavated material used to add to the waterfront building area. A portion of the excavation and fill is being done by steam shovels and trains, but a larger portion is being accomplished by sluicing, using hydraulic giants to break down the material and dredge pumps to assist the sluices as the lower levels of the excavations are reached.

Covering an area of about 50 acres the Morro do Castello is a rocky elevation rising to a maximum height of nearly 200 ft. in the midst of the business section of Rio de Janeiro. On this hill and between its foot

FIG. 1—STEAM SHOVELS HANDLED SOME HUNDREDS OF THOUSANDS OF YARDS

and the waterfront was the original settlement of the city. Before the improvement it was crowned with old forts and church edifices dating back to the sixteenth century, around which huddled the homes of a mixed Latin population. Virtually it had become the city's slums, into which business did not crowd because of inaccessibility for commercial traffic. Also this high land lying between shut off the ocean winds from a large section of the city. To improve these living conditions but more especially because leveling the hill and using the excavated material to build out the shore line would add some 200 acres to its business area, the city decided to cut down the elevation, fill in beyond the old sea wall and build a new sea wall embracing the fill. The plan of this improvement is indicated in Fig. 2.

As indicated by the contours, Fig. 2, the hill has rather abrupt sides. By its removal the area gained for building will be about 185,000 sq.m. or about 46 acres. The area formed by the fill is 612,000 sq.m. or about 151 acres. The volume of material in the hill was estimated as 5,000,000 cu.m., approximately, 25 per

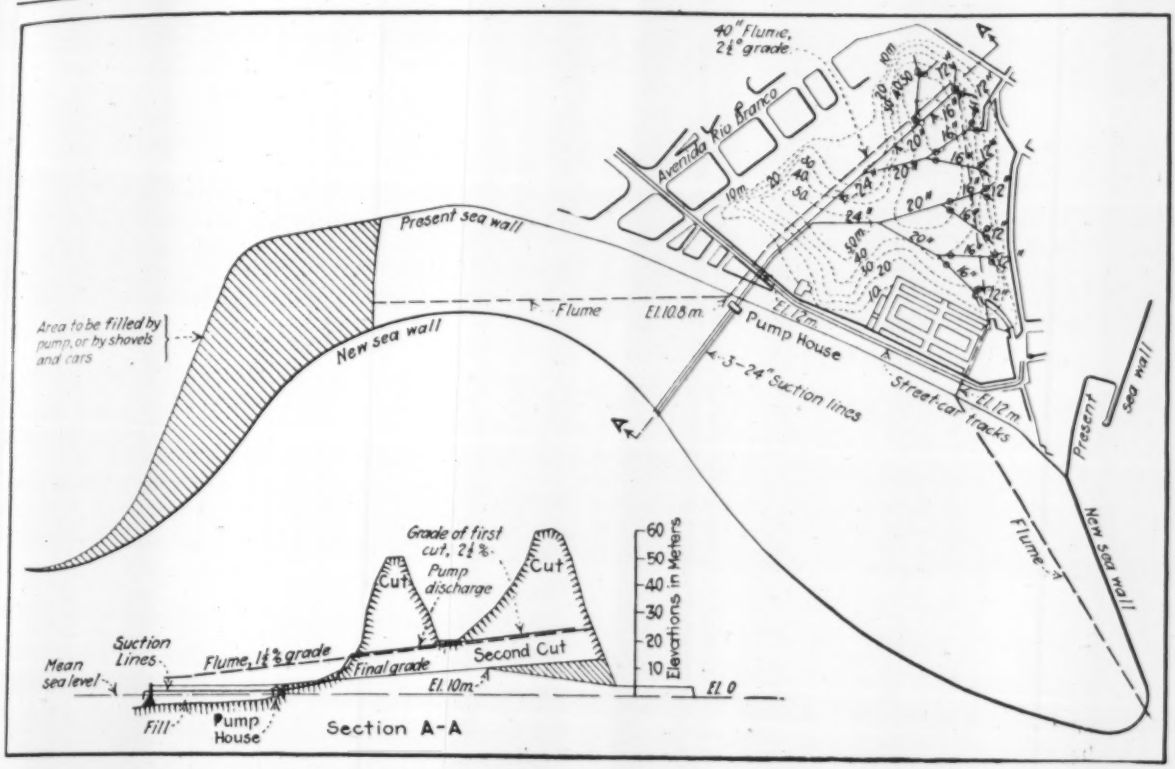


FIG. 2—PLAN OF 5,000,000-CU.M. LAND RECLAMATION OPERATIONS IN RIO DE JANEIRO

cent of which is rock. About 3,500,000 cu.m. have so far been removed from the excavation into the fill. As previously stated, part of the excavation and fill was by steam shovel and trains and a larger part by hydraulicking.

Steam Shovel Work—At the outset the city began work with light German shovels using locomotives and flat cars, motor trucks and mule carts, to transport the excavated material. Later, when American bankers undertook the financing of the work and Leonard Kennedy & Co., Inc., of New York City were made administrators of the operations for the city of Rio de Janeiro, American equipment was installed throughout, except for two German light shovels retained for cleaning-up operations. The enlarged outfit comprised, then, the two German shovels, two railroad-type coal-burning, American shovels, four 30-ton locomotives, forty 12-cu.yd. automatic air-dump cars and one 15-ton locomotive crane. This outfit was put in operation in July, 1922. A view of the steam-shovel excavation is shown by Fig. 1.

Excellent service is reported of all the equipment. The large railroad shovels load from 150 to 250 cu.m. an hour, depending on the materials and the train service. The material is hauled from 1 to 1½ km. and dumped behind a granite quay-wall, which is also a part of the project. The trains consist of eight cars each, and their operation is somewhat delayed as they cross a busy street at grade. Owing to the proximity of the work of the city, all blasting has to be done very carefully and is expensive. Besides the area marked as filled by shovels and cars, considerable other fill is being placed by them because they are available and by being kept busy are earning money. However the great bulk of the fill is being put in by hydraulic methods.

Hydraulicking Operations—As stated, about three-quarters of the hill is decomposed granite, weighing about 98 lb. a cubic foot and consisting of 62 per cent sand and rapidly settling particles and 38 per cent clay and slow settling materials. The binding material separates freely from the sand when water strikes it. A study of the situation indicated that, by gravity sluicing, about 2,250,000 cu.m. could be removed with flumes located 7 m. (23 ft.) above street-car tracks at crossings, the cut being started at El. 12 (m.) and running to El. 23 at the point of the hill farthest from the pumps. On Fig. 2 this is indicated as "first cut." Later the second cut could be removed by the same

FIG. 3—DREDGE PUMPS IN PIT BOOST MATERIAL INTO ELEVATED FLUME

flumes by hydraulicking to sumps and pumping into the flumes. Briefly this was the plan adopted, the general arrangement of pumps, pipe lines and flumes being as shown by Fig. 2. Of course there is no fixedness of location of the dredge pumps nor of flumes and pipe lines, but the drawing indicates the general plan followed.

Broadly the equipment divides into the pumping plant, the pipe lines and the monitors for breaking down the ground; the sluices and dredge discharge pipe lines; and the dredge pump units, of which two are semi-stationary and two are removable.

The pumping plant for the hydraulic giants, Fig. 2, consists of three units each with its separate suction line of 24-in. pipe. Each unit consists of three 16-in. centrifugal pumps in series, designed to deliver 7,500 gal. a minute against 475 ft. head. Each is direct-connected to a 1,200-hp. motor. The three units deliver into a cast-iron header from which the two 24-in. discharge pipes extend into the pit and divide into branches as indicated by Fig. 2. The pipe sizes decrease from 24 in. to 20, 16 and 12 in. The 12-in. pipe reduces to 9 in. at the giants, which range from 150 m. to 900 m. from the pumps.

At the sea ends the suction lines have 24-in. Newman continuous-service foot valves with galvanized steel screens. As the pumps are primed, by means of vacuum pumps the foot-valve flaps were removed and large check valves were used in the 20-in. discharge lines. Owing to the rapid tropical sea growth it is necessary once a week to raise and scrub with steel brushes the outside screens and once in two or three months to remove the entire foot valve and clean the inside screens. Rising-stem gate valves are used for controlling the discharge. In the hydraulicking pit it has been found a time saver to substitute a lever for the valve stem handwheel, it will close the valve against pressure much faster than will the wheel. The giants have 4-in. tips. Fig. 3 shows the pit with giants in operation.

The first cut in the upper part of the hill above El. 15 was gravity sluiced directly to the fill. Below this level dredge pumps in the pit lift the material into the sluices which deliver to a sump on the beach whence other dredge pumps force it through pipe lines to the fill. One of the pit sumps and pumping plants is shown by Fig. 3, and Fig. 4 shows the discharge pipe lines on the fill.

There are four dredge pumps, each 16 in., semi-steel direct-connected to a 500-hp. motor, with 20 per cent speed control, mounted on skis. Two of these are a semi-permanent location on the beach and two in temporary locations at the hydraulicking pit, Fig. 3. These pit outfits are moved up toward the base of the hill as the excavation progresses. All pumps are primed by means of water ejectors, there being a special dredge-type enclosed flap valve immediately connected to the pump on the discharge side. The pumps are designed for 8,000 gal. a minute against 120-ft. head. As indicating performance, at the time of writing, the beach pumps are averaging each 235 cu.m. of solids an hour. The average of the pumps in the pit is 202 cu.m. of solids per hour. One pit pump is discharging through a 212-m. line with a lift of 9 m. and the other through a 555-m. line with a lift of 11 m. The average coefficient of friction is 5.6. The percentage of solid handled ranges from 5 to 13 and averages about 10.

Between the pit and beach sumps open flume is employed. It is 40-in. semi-circular steel with about 45 per cent of the section lined with cast-iron plates. The most efficient grade has been found to be 3½ per cent. The pipe lines from the beach pumps to the fill are 16 in. in outside diameter, with sleeve couplings. Two kinds of pipe have been installed, one a ⅜-in. lap-welded steel and one a special-analysis hard steel. No comparison of wear is yet possible.

FIG. 4—LARGE PORTION OF 150-ACRE FILL PLACED HYDRAULICALLY

As previously stated Leonard Kennedy & Co., Inc., of 67 Wall St., New York, are the administrators for the City of Rio de Janeiro. The work was organized by A. D. Chisholm, with J. W. Armstrong as chief engineer, T. E. Siebenthal in charge of the steam-shovel operation and Nathan H. Jones in charge of the hydraulic work, with D. V. Nystrom as general foreman of the latter operation. The work is now in charge of Nathan H. Jones.

Disinfectant on Garbage Fills

The sanitary fills made in Portland, Ore., as a means of garbage disposal are sprayed with a deodorant consisting of 21 parts of pinoleum to 25 parts of water, which is used when the wind blows from the fills toward residential districts, and with a disinfectant made up as follows: To 1 gal. of carbolic acid is added 3 oz. of caustic soda and ¾ lb. of rosin. This compound is mixed with 100 gal. of water and is then sprayed on the fill.

Development of High Efficiency in Centrifugal Pumps

A Description of a Recent Program of Experimental Design Carried Out in the Hydraulic Laboratory of the University of Michigan

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AMONG the various ways in which centrifugal pumps may be classified one based on their so-called specific speed appears to the writer the most rational. The term specific speed applied to the centrifugal pump has somewhat the same meaning as its perhaps better known relation to the water turbine. Mathematically it is expressed as follows:

$$N_s = \frac{RPM\sqrt{GPM}}{H^{\frac{3}{4}}}$$

The value of the specific speed thus computed establishes the performance of a pump with regard to its three most important elements, speed, capacity and head. The efficiency of a centrifugal pump is often represented as a function of its specific speed.

Another important and very useful method of classification is with reference to the capacity. This is regarded by some as of such importance that the efficiency is expressed as a function of the capacity alone. The fact of the matter is that probably neither method alone will give altogether reliable results and a method based on a combination of the two would be more useful and accurate. This was discussed, at some length, by the writer in *Engineering News-Record*, June 30, 1921, p. 1114.

From an examination of the data published in various books and technical articles one is apt to reach the conclusion that pumps of low specific speed are inherently of low efficiency. One author calls attention to this, adding the remark that for this reason no effort is made to produce such pumps. This article has been prepared for the purpose of indicating approximately to what degree such opinions are justified.

A pump of low specific speed is seen to be one which discharges a relatively small quantity of water against a relatively high head at a moderate rotative speed. Such pumps are easily recognized by the large diameter impeller of narrow width.

This leads to another means of classification of centrifugal pumps with reference to the ratio of diameter of the impeller to its width. Such a method has proved extremely helpful as applied to water turbines and no doubt can be used fairly successfully for the centrifugal pump. Various reasons are assigned for the low efficiency usually found in pumps of low specific speed. From among them two are worthy of special mention, (1) disk friction and (2) internal leakage. By disk friction is meant the power consumed by the friction of the impeller rotated in water, which varies with the diameter as the fifth power. The pressure or head developed varies only as the second power. This indicates (a) that the disk friction increases at a much greater rate than the pressure and that the efficiency is thereby reduced; (b) that it is more efficient from the point of view of disk friction to develop a given pressure with a small diameter impeller at a high rotative speed than with a larger diameter impeller at a lower rotative speed, the peripheral speed being equal in each case. (2) Internal leakage: The high-pressure water is in most pumps prevented from leaking back into the suction of the impeller by means of a very close running fit between the impeller and the stationary walls of the casing. Some designers, in addition to a close fit, employ a so-called labyrinth packing so designed as to increase greatly the length of the path the water must take in its flow through the clearance. The amount of this internal leakage or short circuited water varies with the clearance and the pressure and while it may be but a small percentage of the total pump discharge in the case of pumps of large capacity it should be noticed that expressed in the same way it may represent a considerable part of the discharge of a small pump. This internal leakage means that the capacity of the pump will be reduced by that amount and, worse yet, that power is required to circulate this water, which further increases the power required to drive the pump.

From this it will be seen that we are, in general, limited in two ways in the design of centrifugal pumps for low specific speed.

In spite of the apparent certainty of low efficiency the writer contends: (1) That there is a real demand for pumps of this type, and (2) that if properly designed they may have very satisfactory values of efficiency.

When from the above considerations it appeared likely that the pressure would be too high and the quantity too small for good efficiency the required pressure was developed in two or more stages. This naturally results in an increase in the size and cost of the pump as now two or more runners are required. If a single-stage pump could be designed to do the work it would probably be much cheaper, lighter, occupy less space, and cost less for maintenance and repairs than would a multi-stage pump.

The usual pressure limits for small single-stage pumps (300-600 g.p.m.) seems to be about 150 ft. for best efficiency, although some higher values are found and in some cases some lower limits have been set by their designers.

During the early part of 1919 the writer was engaged in developing a new line of pumps for an eastern manufacturer. This company had formerly built very excellent pumps of European design which were not particularly well suited to American practice. The principal reason for this lay in the fact that owing to the construction of the pump the weight increased very rapidly when designed to receive the larger diameter runners required by current American practice in order to meet the available motor speeds.

The writer's past experience had led to the belief that it would be possible to build pumps for considerably higher heads per stage than were usual at that time and that if properly designed and constructed the efficiency need not be unacceptably low. In order to learn to what extent this might be true a 3-in. pump was designed for a capacity of 400-500 g.p.m. and heads around 200 ft. at a speed of 1,750 r.p.m. Nothing very definite was prescribed and the whole design was mainly

for purposes of study. There were no unusual features connected with this design except that the impeller was of greater diameter and narrower width than the writer had ever designed before. This naturally called for greater care and workmanship in the foundry and machine shop. The ratio of width of the impeller divided by its diameter was in this case about 1/76, which was very extreme indeed, a value which has not often if ever been exceeded.

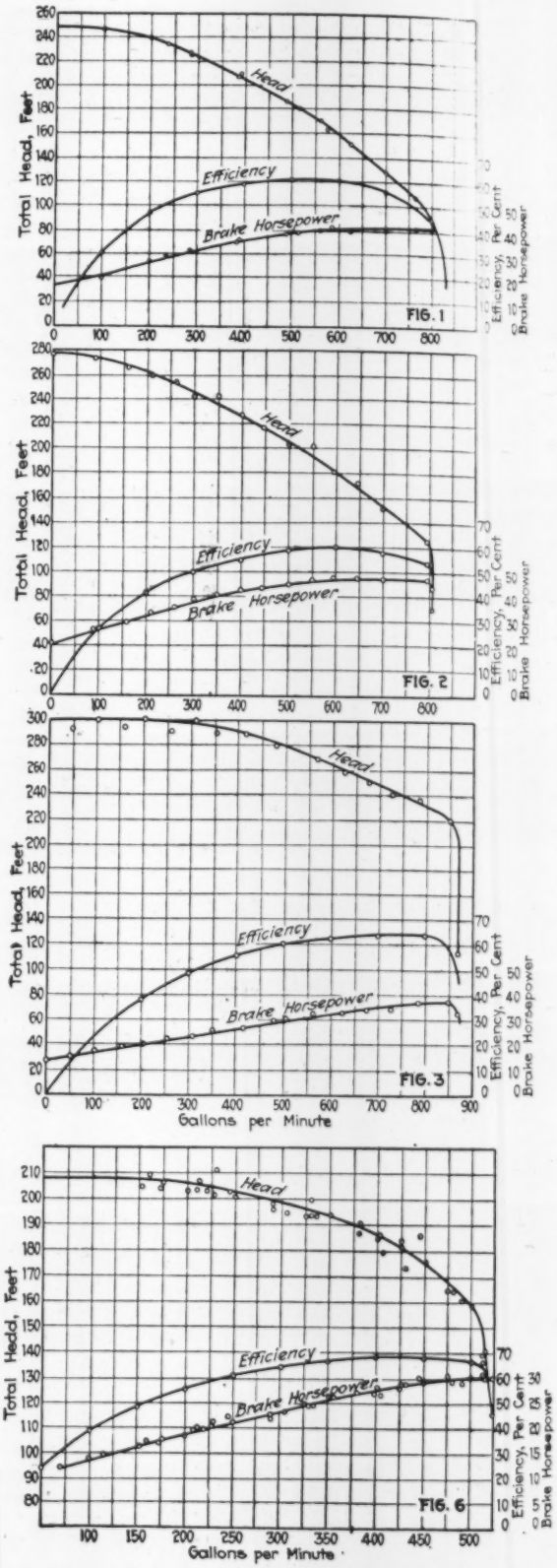
This pump was built in 1919 and tested the early part of 1920. The test results for a speed of 1,730 r.p.m. are shown in Fig. 1. The actual test results were a little different from those expected but nevertheless were very satisfactory indeed. A maximum efficiency of over 60 per cent was obtained at a discharge of about 520 g.p.m. against a total head of 180 ft. A comparison of the results secured by this design with the multi-stage pumps offered for those conditions by other manufacturers indicated that its performance was fully as good as had often been obtained by the use of two or more stages. Other very desirable characteristics were obtained as well. Fig. 1 indicates that the pump was adaptable for a very wide range of operating conditions with but slight change in efficiency. A very flat power curve was also obtained. The specific speed of this pump, as computed by the formula $N_s = \frac{N\sqrt{GPM}}{H^{\frac{3}{4}}}$ is approximately 800.

Prof. R. L. Daugherty in his book on centrifugal pumps shows that for a volute pump having a specific speed of 800 the probable efficiency would be about 52 per cent and that for a pump having an impeller with a ratio of width to diameter of 1 to 76 the probable efficiency would be about 35 per cent.

If we recall that the pump built and tested by me developed an efficiency of over 60 per cent under the conditions named above the figures are very significant and indicate rather unusual performance.

While the writer was still engaged in study and analysis of the test data secured from this pump he was called to the University of Michigan to take over the course in Hydraulic Machinery formerly given by Prof. S. J. Zowski then on leave of absence. The final results of the study made on the performance of this pump seemed so worthwhile that the experimental development of this type of pump was begun in the hydraulic laboratory of the University of Michigan. In April, 1921, the second pump of the series was tested. The results for a speed of 1,700 r.p.m. are given in Fig. 2. The tests on the original pump had indicated more or less clearly the best lines of procedure and these were embodied as far as possible in the second design. Although considerably different in design these two gave about the same characteristics. The diameter of the runner in Pump No. 2 was greater than No. 1 and hence somewhat higher pressures are obtained even at a lower rotative speed. This increase of both capacity and pressure was obtained with no loss of efficiency or of any of the desirable characteristics of the original design. Pump No. 2 was built from an entirely new set of patterns for both the shell and impeller.

As an interesting application of the possibilities of this new development it occurred to the writer to design a pump for such conditions of capacity and pressure as were prescribed for fire service. Accordingly the designs were prepared without delay for a pump to deliver 750 g.p.m. against a total head of 231 ft.,



CHARACTERISTIC CURVES FOR 3-IN. EXPERIMENTAL PUMPS NOS. 1, 2, 3 AND 5

equivalent to a pressure of 100 lb. per square inch. To reduce the expense as much as possible, as well as to permit the use of a portion of the existing patterns,

this pump was also designed as a 3-in. pump having a 4-in. suction. Obviously better results would have been obtained had the pump been built as a 5- to 6-in. size as was subsequently shown by later tests. This pump was tested in June, 1921. Fig. 3 gives the characteristic curves of the pump when tested at 1,750 r.p.m. Fig. 4 shows the equal efficiency curves for the same pump at speeds of 1,750, 1,450 and 1,150 revolutions per minute. Attention is called to the extremely flat efficiency curve in Fig. 3 as well as to the wide range in capacity and pressure with relatively high efficiency shown in Fig. 4.

The pump developed a maximum efficiency of 64 per cent at a capacity of 750 g.p.m. against a head of 240 ft. at 1,750 r.p.m. The results of this test exceeded all expectations by a considerable margin, and it is believed that, everything considered, it established a record not yet equalled in European or American practice. The underwriters specify that a pump offered for this service shall be an 8-in. two-stage design and that the efficiency shall not be less than 55 per cent, the expectation being that it will vary between 55 and 60 per cent. Later tests indicated that several per cent could have been added to the efficiency by an increase in the size of the pump. Inasmuch as an efficiency of 64 per cent was actually obtained under the conditions named, it is probable that had this pump been designed as a 6-in. instead of a 3-in. pump the efficiency would have been not far from 68 per cent. This would be fully as good if not better than that developed by the average multistage pump for these conditions.

It should be pointed out that these results were obtained with a simple volute pump without the use of any guide vanes or diffusors. This still further confirms my belief that guide vanes and diffusors are entirely unnecessary in pumps of careful design and equally good results can be obtained without them. The writer is well aware that others may still prefer to use them but maintains that it is possible by proper design to secure the same results without.

In the light of this the results obtained from this 3-in. pump are surprising to say the least. The average pump offered for the same service would weigh in the neighborhood of 2,000 lb., while the total weight of the pump whose results are shown in Fig. 3 was only 412 lb. This indicates that it has been possible to reduce the weight of the pump from about 80 per cent with little or no loss of efficiency. The cost of this pump would be somewhat in the same proportion although probably not as extreme a variation. The writer believes that this design has established, by a considerable margin, a new record for large capacity and high pressure with light weight. Strength was in no way sacrificed in this design and the pump would be amply safe under much higher pressure than it was called upon to meet.

Up to this point efficiency had been considered of secondary importance and no especial attempt had been made to secure high efficiency. The previous designs were primarily for the purpose of study and it was desired to see what values of efficiency might be obtained.

Space does not permit an account of the various tests, studies, etc., which were undertaken with these designs but it will be sufficient to say that after a careful study of all the test data there were strong indications that an improvement in the efficiency was possible. With this in mind a new impeller was designed for somewhat lower capacity and pressure in order to keep within the easy test range of the dynamometer. This design was undertaken in an effort to improve the efficiency without disturbing the other desirable characteristics previously obtained, such as the extremely flat efficiency curve. This impeller was tested the latter part of 1921. Fig. 5 shows that my prediction of increased efficiency was fully realized.

A comparison of Fig. 5 with Fig. 2 shows that an increase of about 7 per cent in efficiency was obtained by this new design. It was also considered likely that the new design would show even less variations in efficiency with varying capacity than had been obtained with the previous pumps. This too was borne out in the subsequent tests. A remarkable feature of this pump is the unusually wide range of capacity and head —more than half the total possible—for which the efficiency is 60 per cent or better. In other words this pump will develop within 35 per cent of its maximum efficiency at half its normal capacity or about 5 per cent more than is usual in such cases.

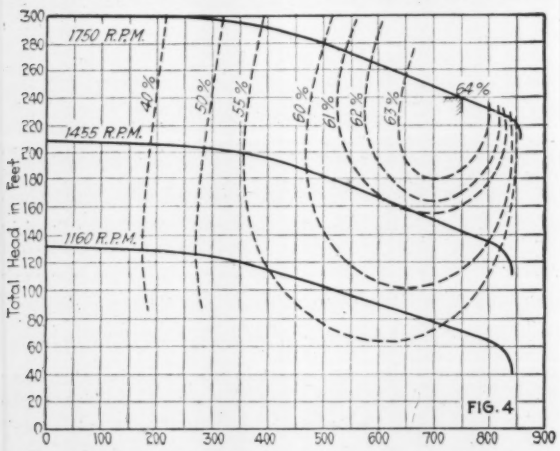
After a careful study of these tests it was thought that by proceeding in a slightly different direction it would be possible to still further increase the efficiency of this type of pump. Owing to the pressure of other matters the work on this pump was at a standstill until in August, 1922, the design of a special pump primarily for high efficiency was undertaken. This pump was designed for smaller capacity but about the same pressure as those in the past. The tests were made in November, 1922, with the results shown by Figs. 6 and 7.

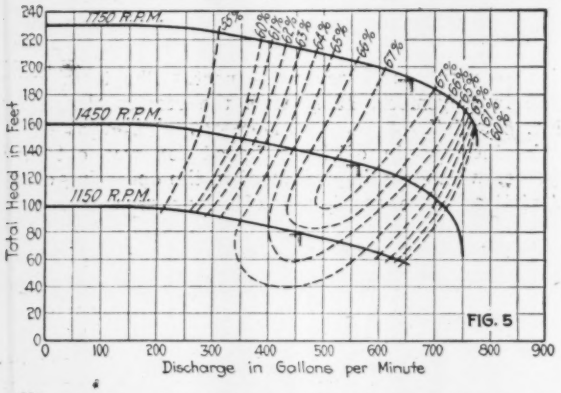
The increase in efficiency hoped for was obtained together with some improvement in the operating characteristics. The maximum efficiency was increased from 67 to 68.5 per cent or 1½ per cent in spite of the decrease in capacity from 650 to 425 g.p.m. This makes the results even more remarkable as the usual effect of a similar reduction in capacity is a decrease of 3 to 4 per cent in the efficiency.

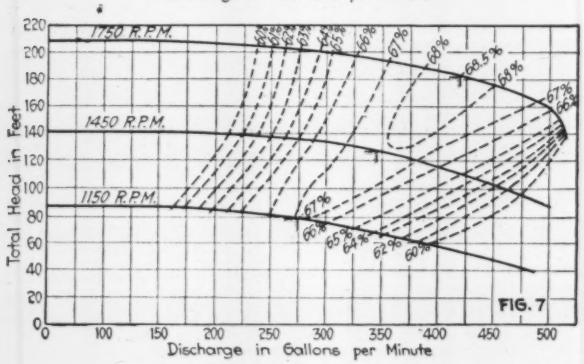
For the same capacity and pressure the efficiency was increased from 62.5 per cent in Fig. 5 to 68.5 in Fig. 7, a total of 6 per cent. Without regard to the high efficiency developed by this single-stage pump at heads around 200 ft. the curves of Fig. 7 are interesting for their broadness. The efficiency at half load is about 86 per cent of its maximum which is higher than usual by several per cent. The effect of this is very evident in the tests at lower speeds. For instance the development of 67 per cent efficiency with a discharge of only 275 g.p.m. under 80 ft. head at 1,150 r.p.m. is not exceeded by any pump which has come to the writer's attention. In efficiency, operating characteristics, etc., it is the equal of many of the 4- and 5-in. two-stage pumps offered for such service by manufacturers today. The total weight of this pump was 380 lb., which is perhaps half or less that of a two-stage pump offered for this service with no better efficiency.

The writer hesitated to publish the results of this work until such a time as he could be sure that these pumps had been in operation a sufficient length of time to warrant the belief that their initial satisfactory performance would be maintained in the future. To date nothing has occurred to indicate that they have any difficulties inherently connected with them, and they seem perfectly normal in every respect. Fig. 8 will

give the reader an idea of the general construction of these pumps. Ball bearings of the radial-thrust type furnished by the Gurney Ball Bearing Co. were used on all the pumps. Otherwise there were no particularly novel features affecting their general appearance. The operation of the ball bearings was highly satisfactory in every case. The tests were very carefully conducted and check runs were always taken to secure accuracy.







EQUAL EFFICIENCY CURVES FOR 3-IN. EXPERIMENTAL PUMPS NOS. 3 4 AND 5

The power was measured by means of an electric dynamometer, the pressure by calibrated test gages and the speed with a highly accurate form of tachometer. The results may be regarded as correct within a very small margin. The pumps are entirely of commercial design and are in no way to be considered as freaks. The workmanship and materials were first class in every respect.

The writer hopes that this brief account of the development of this type of pump may prove to be the means of stimulating further work along these lines. An exceedingly bright future is predicted for this type of pump if adapted to commercial requirements, as it seems to have all the good characteristics of multi-stage design with few or none of their well known disadvantages. It should be understood that many of the refinements of design used in the production of these rather high pressure pumps are entirely applicable to those for moderate pressures. The efficiency of centrifugal pumps is known to vary with the capacity, other things being equal. This variation is rather well known and has been represented by various curves showing this relation. For volute pumps having a capacity of 275 g.p.m. the probable efficiency would be about 60 per cent in the usual case. For pumps of about 4,000 g.p.m. efficiencies as high as 85 per cent have been obtained.

The pump shown in Fig. 7 is seen to develop about 7 per cent more efficiency than the usual design. It seems not at all improbable that by the use of these same methods of design the efficiency can be raised about that amount all along the line. This should result in maximum values of efficiency in the neighborhood of 90 per cent and one long-hoped-for dream of the pump designer—that of equaling the efficiency of the water turbine—would then have been realized.

Rehabilitation of the Kansas City Southern Ry.

Study Made for Systematic Improvement—Grade and Line Revision—Track Rebuilt—Bridges Strengthened or Filled

LIGHT original construction to meet financial conditions, with subsequent extensive rehabilitation and improvement to develop operating economy and traffic capacity, has been the history of many American railways. This condition, as illustrated by the Kansas City Southern Ry., is presented in the annual report of that company in a reprint of an address by L. F. Loree, chairman of the board and an engineer of wide railway experience. Some brief extracts from this address are given below. The original line was described in *Engineering News*, Feb. 17 and March 10, 1898, pages 116 and 162.

The Kansas City Southern Ry. was a conception of Arthur Stillwell, whose purpose it was to bring Kansas City into connection with the Gulf of Mexico by the shortest practicable route. Partly by new construction and partly by the purchase of small lines, the road was completed and opened for operation in 1897. The difficulties both of location and construction had been very considerable. The traffic was thin, 887,108 tons being hauled one mile per mile of road in 1905; the bridges were light, having been built for Cooper E-31 loading; the rail was light, 60- and 56-lb. per yard, and was badly surface-bent because laid on dirt ballast. Sidings, yard and terminal facilities were inadequate. The grades on no division were less than 1 per cent and increased in the mountains to 1.8 per cent.

The new owners who took over the road in 1905 proceeded at once to deal energetically with these conditions; first in overcoming the more outstanding defects, while careful and painstaking study was made of the problems of maintenance, operation and traffic. The services of an experienced engineer, supplemented by a large field force, were secured to study the possibility and cost of grade reductions. These studies extended over 1906 and 1907,

and the conclusions reached have been closely adhered to in the subsequent development.

In the modernization of the property, the roadbed both in cuts and on fills has been widened to a standard cross-section, and much attention has been given to surface and sub-drainage, especially in the gumbo soil of Missouri. The line has been relaid throughout with 85-lb. rail and with the improvement of the condition of the main line rail has gone a corresponding improvement in that of yards and sidings. Each year a substantial percentage of the cross ties used has been subjected to preservative treatment until now 51 per cent of the ties in main track are treated. About 90 per cent of the line has been raised 6 to 12 in. on gravel or chat ballast, while some material has already been applied to the remaining 10 per cent. The line and surface, and generally the maintenance of the track, compare favorably with other lines in the Southwestern territory.

A carefully maintained bridge program has been followed, looking to a reduction in the number and length of wooden trestle openings and to the strengthening of all bridges to permit heavier loading. Several trestles are now of the ballasted deck type and of creosoted timber. The new bridges have been built for the Cooper E-50 loading, and two are of large size, one over the Kaw, built in 1917, costing $225,000 and one over the Arkansas, now under construction, estimated to cost $270,000.

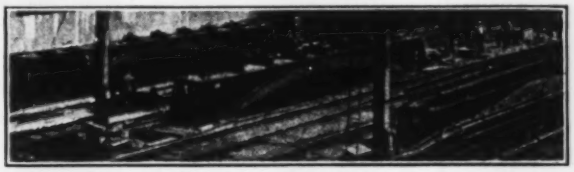
The passing sidings have been progressively extended, their total having been lengthened 34 per cent, until this work is now about two-thirds completed, and they will accommodate the longest trains moved by the heaviest power over the lowest grades. Water and coaling stations have been revised to suit the changed conditions of traffic, water treating plants have been installed where water conditions are bad, and five gravity coaling tipples have been built, as well as adequate facilities for storing and delivering oil fuel for locomotives.

The traffic offered the Kansas City Southern Ry. is low grade freight such as lumber, coal and grain, that must be moved at low rates. In order to obtain a profit from the business, a movement as nearly balanced north and south as possible is necessary. The margin of profit is sharply reduced with the traffic out of balance and might entirely disappear with a large amount of empty mileage. Further, it must be moved in heavy trainloads and with a minimum of lost motion or delay. It was with these difficulties of operation in mind that the late Horace G. Burt, in presenting his exhaustive field investigation, reported that a line might be practically realized of a maximum gradient of 0.5 per cent. More than $5,000,000 have been spent for grade reduction, and the property is now operated as five divisions of 0.5 per cent, one division of 1 per cent and one of 1.35 per cent maximum grade. These changes in grade have yet to be pursued to a finality.

Old Cast-Iron Structures on British Railways

REPLACEMENT of a cast-iron railway bridge 88 years old and of cast-iron columns of a trainshed 69 years old, on two English railways, is reported in the *Railway Gazette* (London). The bridge, built in 1835, has a span of 50 ft. It carries four tracks across the Regent's Canal in London, near the Euston terminal station of what is now the London, Midland & Scottish Ry., so that an enormous main-line traffic has crossed it. In view of the great increase in weight of English locomotives during the past few years the removal of the bridge is not surprising, especially as it had been strengthened several years ago.

This bridge had three shallow through trusses of the bowstring type, each truss consisting of two parallel flat arched ribs of I-section with vertical spandrel members and a horizontal top chord over the full width, as shown herewith. The two sets of spandrel members were connected at intervals by cross frames. Wrought-iron hangers carried cast-iron cross-girders or floor-beams. In 1892, however, intermediate steel floorbeams were placed, suspended from the chords and ribs by steel slings or stirrups, the attachments being so adjusted that these steel members carried all the live- and dead-load. Cast-iron plates formed the floor originally, but a plank deck with wood stringer for each rail was laid about twenty years ago.



CAST-IRON TRUSSES OF ENGLISH FOUR-TRACK RAILWAY BRIDGE

The third truss (right-hand view) is partly concealed by a modern plate girder span carrying a fifth track at the right.

The new five-track bridge will consist of six parallel plate girders with transverse floorbeams carrying brick jack-arches and a concrete waterproofed deck for ballasted tracks.

The trainshed roof of the Paddington terminal station of the Great Western Ry., at London, built in 1854, was supported by round cast-iron columns on cross-shaped bases resting on small brick pedestals of the same form. For the renewal of these columns, two steel bents were erected at each column in succession, carrying I-beams which were wedged up to carry the arch rib supported by the column. The old column was then taken down and the brick pedestal replaced by a more massive concrete pier, with anchor bolts for the steel column base, as the brick pedestals were hardly adequate for the loads. The new column was then set, a 4-in. downspout inserted, and the column adjusted to position, after which the space between downspout and column was grouted. These columns, also of cast iron, are of octagonal section 15½ in. in diameter at the head and 17½ in. at the base, with a length of 24½ ft. After final adjustment, the bents were released, to transfer the load to the column, the column bases were cased in concrete, drain connections were made and ornamental cast-iron caps and bases were placed. The columns along one platform have been renewed and the work is to be completed before winter.

Through the Reclamation Country

By F. E. Schmitt
Associate Editor, *Engineering News-Record*

A SERIES OF ARTICLES on Federal Land Reclamation is to start in *Engineering News-Record* in a few weeks. It will give a history of the twenty-one years of government irrigation, state the many problems of operation—engineering, agricultural and financial—analyze the various complaints that are being so emphasized by those who are seeking a reform of the current law and methods and seek to present some views as to a constructive policy in the future. Through it all will run the evident theme that irrigation, from planning, through construction to operation, is a continuing engineering problem.

As a part of the preparation of the series Mr. Schmitt is now traveling through the West, visiting irrigation projects, studying developments and interviewing builders, operators and settlers. He will write a series of letters of running comment on the situation as he sees it on the ground. These are not the final result of his trip but they will serve to acquaint our readers with the actualities of reclamation as revealed to an unprejudiced investigator. —*Editor.*

Washington, D. C.

ON THE WAY to visit some federal reclamation projects I find that local observers of government doings believe that quite a muddled situation has developed out of the current mixture of federal reclamation and politics. Three months ago the Secretary of the Interior killed off and buried, decently or otherwise, the 21-year-old Reclamation Service, which in long and faithful performance had come to be close to the hearts of engineers and incidentally had made several million acres of desert bloom more or less like a garden. He erected a Reclamation Bureau on its grave, and converted a politician into a statesman by making him Commissioner of the Bureau. The facts, the Secretary in effect explained, condemn the engineer-controlled Reclamation Service; hence the Bureau. But now, three months later, he appoints a "fact-finding commission." So at last we are to be instructed with facts. Will they show that the Service should have been kept alive?

To my question, "What is the new commission for?" one man I met here answered, "Smoke screen!" The next man, equally shrewd though of different type, gave the same answer, "Smoke screen." The coincidence is striking. People close to the government naturally see its seamy side. But is it significant that the official action of one of the ten highest government personages should be promptly and spontaneously impugned as political subterfuge? And this action concerns a matter of outstanding national importance; not merely the welfare of a hundred thousand people on the farms, not merely the soundness of an investment of more than a hundred million dollars of the people's money, but the future development of our remaining unused land, with all that it means in production and in home-making.

They say in Washington that the Secretary has been unpleasantly surprised by the widely expressed disapproval and distrust aroused by his A. P. Davis - D. W. Davis coup d'état; that he is now trying to divert attention from it and perhaps build up a basis for new claims or policies which will lead people to forget the case of the engineers and of the late lamented Reclamation Service. If this is correct, it is about the first time that the engineering profession has made its voice heard and has dented the hard shell of a government official outside its own ranks. The protests of engineers, it is true, were backed by those of many newspapers which know something about reclamation. Nevertheless, the engineering profession has cause for some slight rejoicing.

There are plenty of predictions that the new Congress will take up the reclamation subject aggressively, as of course it ought, in view of the importance and urgency of the matter. But quite apart from politics the situation is obviously a big national problem, in which the Davis-Davis incident is merely a symptom and not the trouble itself. Such local evidence as records of committee hearings of the past year or two shows that there is much complaining in the irrigated areas of the West; and the complaints seem to mean that a cost burden of $40 to $80 per acre for water-supply works alone, plus annual operating charges, plus cost of land leveling, is a heavy load on a farm that lies far from markets and has to compete with fertile land amply watered by nature. Some of the reclamation areas are reported to be seriously in trouble, while others, with very likely the same kind of people on them, are clear or are coming clear. There is room for a good deal of fact-finding. Besides, men informed on personalities tell me that part of the complaining has come from kickers—kickers by temperament or by profession—and does not represent the sentiment of the genuine hard-working farmers along the ditches.

There is one phase of the matter that has a family interest. Just ten years ago this journal printed a number of protests concerning the difficulties against which the reclamation farmer must labor, all of them amounting to the assertion that his first four or five years are the hardest and that he cannot begin to repay the reclamation cost so early. "Let up on him during his pioneer years" was the burden of the protests. The protestors of the past two years have said exactly the same things, although their particular projects have been producing for six to ten years now. Is the reclamation farmer still pioneering? If he is ever going to pull out of the hole why are the present protests largely duplicates of the old ones? The situation doubtless has changed; but it is easy to keep on with an old line of talk, even though new talking points have grown up. Just how the situation has changed, and what new hardships have developed to take the place of those of 1912 and 1913 also needs to be found out.

Panama Canal Tonnage Increases

The net tonnage of vessels transiting the Panama Canal during the fiscal year which ended on June 30, 1923, showed an increase of 63 per cent over the tonnage for the same period last year, this year's figures being slightly over 18,600,000 tons. Another interesting fact concerning this movement through the canal is that with very few exceptions the number of vessels each month is slightly greater than the number in the preceding month so that whereas the number for July, 1922, was 206, the number for June, 1923, was 417, which figures would indicate that the growth in canal traffic is increasing regularly. The toll collection from the 3,967 vessels which transited the canal during the past year was $17,500,000. Net profit on Canal tolls now amounts to about $500,000 monthly.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Dealers' Profits on Cement to Large Users

Sir—The issue of Sept. 6, 1923, is before me, and I note your editorial remarks concerning the analysis of federal income tax reports of several cement companies and the conclusion based thereon by H. Parker Wills as outlined on page 407.

As a buyer of cement, I see no just cause of complaint, either as to the price which the mills receive for their product, or the profit which their returns show they are receiving from the use of their capital. Theirs is a somewhat uncertain and irregular business, in that it is subject not only to seasonal fluctuations but also to all the chances and changes which both local and world conditions tend to bring about.

What the state and municipal authorities are trying to do, as I understand the situation, is to bring about a change in the marketing methods of cement companies which will result in the placing of the states, counties, and municipalities on the same basis as the local dealer. We object seriously to paying a tribute of from 25 to 60c. per barrel to the local "representative" of the mills, despite the fact that his only service to us is to write an order for the quantity we may need. We are perfectly able to write these orders for ourselves, have our own storage, and in all cases take the cement from the car with our own labor and trucks.

We have the cash to pay for the goods, and yet we must pay tribute to a dealer in every case, although in many cases, the dealer does not sell in a year as great a quantity of cement as we often use in a month in the busy season.

It is this, to us, unfair attitude of the cement mills which has caused the agitation for state-owned cement mills and which will keep up this or other equally ill-advised agitation until some relief is given the user of cement in large quantities. We will not forever go on paying a tribute for which there is no justification in sense or reason. And if at some time in the near future the cement makers find themselves in the same fix with the railroads they will have only themselves to blame.

Nearly two years ago, the writer, with the board of commissioners of this county, was invited to dine with the officials of one of the great cement companies of the middle west, the object of the getting together being to try to arrange for the use of their cement on our work. During the discussion of the matter we frankly stated that so long as we had to do business with them through a local dealer, and pay an unreasonable tribute to him, we would never be found among their customers, and we further stated that at the coming session of the state legislature we were planning to have action taken which would place counties and municipalities or any one else buying their product in car lots on the same basis as their regular dealers, so far as price was concerned. Their reply to this was that so far as their particular company was concerned they were willing to make such an arrangement but owing to the "Association" rules they could not act alone; the matter was in process of being threshed out at their meetings and they had no doubt that within a year we would be able to buy their product on a dealers' basis. We have used a great many cars of cement since that time, but have not been able to buy any of it without the local dealer "getting his," nor have we bought any from that particular mill until last month when we bought two cars through their dealers at and below the price we have been paying a dealer representing another company whose ideas of "profit" were more nearly in line than theirs had been heretofore. If to regain our trade, which they had lost, they could cut their "margin" in one case 76c. per barrel and in another 87c. per barrel, it would seem that there never had been any legitimate foundation for their prices.

The cement makers are "in bad" with the public, and, the public does not always stop at reasonable concessions from those who it feels have unjustly dealt with it. It is high time the cement makers took note of the storm signals and began to throw a little oil on the waters. It will prove as effective and much cheaper than a price cut after state-owned mills are in operation. They are entitled to all the profit which their returns show they are getting from their business, and what the public is demanding and will get sooner or later is not so much a reduction in price as it is a reduction in the "spread" between the mill and the job.

While the product of the cement mills was a new and comparatively unknown quantity, there was an excuse for maintaining a dealers' organization as well as an association of manufacturers, who by their combined effort could at comparatively small expense carry out the advertising campaigns necessary for putting before the possible consumer all the facts and arguments which might induce him to try their product. But at this time with every one familiar with the use of cement it would seem that their efforts and money could be better spent perfecting their product and bettering their marketing facilities and methods, than in supporting an "association" upon which the people look with disfavor—however innocent its purpose—and which is more and more attracting the unfavorable notice of the courts.

If Mr. Wills' analysis is based on truthful and fair returns from the companies considered, their profits are certainly conservative and no one should have any quarrel with them. But when we go to their mill door with the cash in hand to pay for our cement, we do not like to be referred to some dealer to whom we must pay tribute before our wants can be supplied.

O. T. REECE,
County Engineer, Neosho County, Kansas.

Erie, Kansas,
Sept. 10, 1923.

Reproduction-Cost-New Measure of Value

Sir—Recently I had occasion to reread your editorial comment in the issue of June 7, 1923, on the decision of the Supreme Court in the Missouri telephone case, and apparently your view is that the minority opinion of the court is the more sound, namely that legitimate prudent investment should be the rate base instead of cost of reproduction at the date of inquiry.

It seems to me that your editorial as well as other advocates of the prudent investment theory neglect two factors which are of prime importance.

1. While original investment is stated in terms of dollars, the real investment was labor and materials. The total amount of these constitute the capital invested and the investment should be measured by these rather than by the fluctuating dollar. If the investment is measured in these terms, the prudent investment becomes essentially equal to the reproduction cost. The difficulty lies in considering dollars as capital instead of merely a medium of exchange of capital or elements of ultimate value. A fair return on the real investment of capital should be provided, and this return should be in terms of the medium of exchange in vogue or applicable at the time the return is being contemplated. Reproduction cost is essentially this investment quoted in terms of the currency of the time of inquiry.

2. As a practical procedure, the term "prudent investment" offers no advantage over "fair value," for "what is prudent" or "what is imprudent" is quite as vague as "what is fair," each having to be determined by evidence and judgment.

Moreover, as a practical procedure, records of additions can be as readily kept in terms of material and labor as in terms of dollars. As a matter of fact, the record is necessarily kept in both forms, although more conveniently summarized or tabulated in terms of the common medium, dollars.

Justice as well as stability requires that the same economic laws be applicable to public utility property that are operative for private property, and this means that investments in public utilities should be as sound as investments in hotels, apartment houses, banks, mercantile houses, or realty.

While probably most engineers will agree that a better term than "fair value" might have been chosen as a basis of rates, yet the concept involved is doubtless sound. "Invested capital" or an equivalent term would have been more definite and advantageous in many ways. However, the "invested capital" should not be construed as meaning the dollars invested but rather the real capital invested.

Recognition of the soundness of the Supreme Court decision of May 21 in the case mentioned will do much to dispel the fogginess of appraisal procedure, a consummation devoutly to be wished by every engineer engaged in work of this character.

C. C. WILLIAMS,
Urbana, Ill. Head of Department of Civil Engineering, University of Illinois.
Sept. 8, 1923.

[Comment on this letter appears on the editorial page of this issue.—EDITOR.]

Eccentric Heel Joint

Sir—Referring to the eccentric heel joint problem brought up by Camillo Weiss in your issue of Aug. 30 p. 339, and also by Walter H. Weiskopf in your issue of Sept. 13, p. 447, I should like to recommend again a simplified method, one that a man can carry under his hat without the use of a formula or the influence line, as suggested.

In 1915 I proposed a method. Prof. E. H. Rockwell pointed out an error in that method, an error that could readily be corrected without affecting the principle of the solution. At that time I endeavored to show in *Engineering News* how the error could be corrected, also to point out

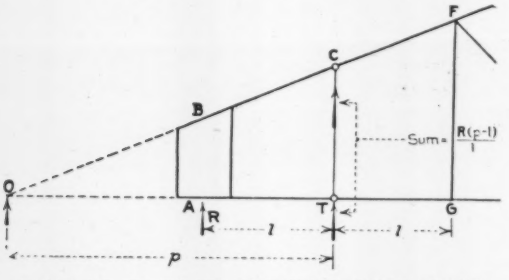


DIAGRAM TO SOLVE ECCENTRIC HEEL JOINT

the need of some correction in Professor Rockwell's solution. However, Professor Rockwell became ill and could not respond until a time when the matter was too "cold" for publication.

Stripped of theoretical niceties the method is simply this: Given, a truss heel joint, as in the figure herewith; assume equal degree of fixed-endedness at *B* and *F* and at *A* and *G*, so that points of inflection occur midway between these points. Continue the chord members to their intersection *O*.

Now consider the reaction *R* as a load on a beam of span *OT* or *p*. The reaction at *O* may be used either analytically or graphically to find the direct stress in the chords *BF* and *AG*, and the reaction at *T* may be used as a shear divided between these chords and producing bending moments at *B*, *F*, *A*, and *G*. This is all there is to remember, except that the last reaction should be divided between the chords in the inverse ratio of their stiffness or their moments of inertia.

It is scarcely necessary to introduce the different lengths of the chords, as affecting their proportion of shear carrying capacity, inasmuch as for roof trusses an approximation is all that is desirable, and, in any event, the horizontal distances are alike.

EDWARD GODFREY.
Pittsburgh, Pa., Sept. 20.

Personal Element in Water Bacteria Research

Sir—One feature of your editorial discussion of the recent action of the California State Board of Health (*Engineering News-Record*, Sept. 13, p. 417) was not emphasized. The plan of the board if carried out would insure more or less careful attention to water analysis on the part of many, perhaps several hundred, independent workers. The result of such increased opportunity for many investigators, even if amateurs at first and for a long time, can hardly be overlooked. There would be greater interest with more than a fair chance that from so many different viewpoints some actual gains would be made in the state of the art, even if only the simplest tasks were undertaken. Note the improvements in radio from almost numberless sources. The really difficult problems could be reserved for the expert.

Analyses require faithfulness and honesty as well as skill. Good judgment is important. There must be for each city or unit-installation some one intrusted as superintendent or manager with the responsibility incident to caring for the plant as a whole. To him any part might be understood after a reasonable opportunity to learn had been afforded; that is, the same qualities that had secured to him his position should be ample to enable him to take on the increment. No serious risk could be involved since the average case would invite some further knowledge of the daily supply. Whatever adds to the welfare of an isolated unit should be welcome in quite as deep a sense as those items which add to the activities of the state.. The California plan seems to have its advantages.

H. F. DUNHAM,
New York City, Civil and Hydraulic Engineer.
Sept. 19, 1923.

One Cause of Earth Dam Failures

Sir—In the meritorious editorial in your issue of Sept. 6 relating to the recent failure of the Apishapa earth dam, it is affirmed that the difficult sequel of all such dam failures is to discover just what that something is that went wrong; you also questioned why there should be such diametric opposition as to the desirability of early filling of the reservoir behind dry fill earth dams as was evidenced by the contradictory views of the engineers reporting the disaster; and you declared that the essential development of the art of designing earth dams for varying local conditions and purposes should be furthered by determination of the actual causes of past failures.

I have seen six ruinous breaks, and several minor ones in earth embankments built for cofferdams, canal banks, and river dikes.

In most instances the primary cause of the break was the solid freezing of the embankment for several feet in depth below the top. The frozen part expanded and a definite crack was formed along the plane dividing the frozen from the unfrozen section as the frozen part shrank to its original size when free of frost. Under a slight head of a foot or two, water entering the horizontal crack gradually seeped along it till finally a leak was started.

In a new earth dam standing in the dry during the winter, similar cracks may be formed roughly paralleling the side slopes. When subjected to pressure later on, water entering the horizontal crack near the top can follow down the vertical cracks and into any pervious horizontal layer it may reach.

In Northern Michigan where the snow is generally three or four feet deep on the level throughout the long winter season, I have kept cofferdam embankments from freezing by piling loose brush on them, thus forming a brake for keeping the snow from blowing off the bank. Compacting the snow by walking along the dam was not permitted. Where the natural fall of snow is deep and is not disturbed, there will not be any frost in the ground, but under packed paths made in the snow the ground will be frozen four to eight feet in depth when night temperatures go to ten or more degrees below zero. Determination of depths has been made many times by excavations or by drilling holes.

JOSEPH RIPLEY,
Albany, N. Y. Consulting Engineer.
Sept. 24, 1923.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

The Tehachapi Railway Co. Has been organized in California with a capital stock of $1,000,000 for the purpose of constructing 30 miles of railway in Kern County, Calif., between Ilmon and Bena.

American Bridge Co. Was the Lowest Bidder for the construction of 19 steel barges for the U. S. Government to be used in the construction of the new dams on the Ohio River. They are to be ready for use in the spring.

Reports That the Great Northern Ry. Co. plans to build 80 miles of new line from a point near Java on the southern border of Glacier National Park to Augusta, Mont., are stated to be without foundation by the chief engineer of the Great Northern Ry.

To Relieve Congestion Arising from the fact that the 4½-mile tunnel under the Severn River frequently is inadequate to carry the volume of traffic between England and South Wales, the Great Western Railway Co. has announced its intention to construct a bridge across the river at Beachley, a short distance above the tunnel.

Three of the Four Main Piers for the Bear Mountain-Hudson River bridge have been completed up to the bridge seat level and the fourth will be completed some time this month. The company will then be in a position to set the cast-steel tower bases and start the erection of the steel towers. Work on the approaches is well under way.

Bids Are Being Asked for the reconstruction of the substructure of the Georgia-Alabama bridge over the Chattahoochee River at Eufaula, Ala. The present wooden latticed-truss bridge was built about 1837 and the brick piers were built in 1855 to replace the original wooden ones. These piers are to be encased in concrete and the wooden trusses replaced by steel ones as soon as the necessary legislative enactment is obtained.

Reports from Mexico State that that country has announced plans for the creation of three free ports—one at Salina Cruz, one at Port Mexico, and one at Guaymas. A fourth will be added in the future at Rincon Antonio on the Isthmus of Tehauntepec. These free ports are based on the successful free ports of Europe and comprise areas where commercial operations not intended for consumption in the rest of the country are free from customs duties and regulations. They also provide reservoirs for storing material pending shipping orders. This announcement follows one from Belgium that 650 acres have been allocated to this purpose at Zeebrugge.

Japan's Great Earthquake Described by American Engineer Eye-Witness

John W. Doty, President of Foundation Co., New York, Viewed Destruction of Yokohama, Sept. 1, from Deck of Ship at Pier Which Collapsed During Shock

The effect of the great earthquake which devastated cities in Japan, Sept. 1, as seen through the eyes of an American engineer, is told in the following diary of John W. Doty, president, The Foundation Co., New York. At the time of the shock Mr. Doty was in Yokohama harbor as a passenger aboard the Canadian Pacific steamship "Empress of Australia," which was just on the point of casting off from her pier for her return voyage when the disaster occurred.—EDITOR.

ON SATURDAY, Sept. 1, at 11:45 a.m. all passengers were aboard the *Empress of Australia* in Yokohama harbor, the gangplank was removed, and the ship was ready to sail. The tug was alongside. Several hundred visitors were on the pier adjacent to the ship waving farewell. The ship lay with her bow toward the shore, her starboard side along the pier, about 1,200 ft. from shore. From the stern of the ship the pier projected out into the harbor another 600 to 700 ft., its total length being about 2,200 ft. Lying directly astern of us on the same side of the pier was the *Steel Navigator*, a ship of United States registry, and on the opposite side of the pier was the French liner the *Andre Lebon*. Both of these ships had gangways on the pier.

At 11:57 a.m. when every one anticipated that we were leaving the pier, a tremendous vibration of the vessel was felt and it was immediately apparent that a serious earthquake was taking place. Many people on the pier adjacent to the vessel fell to the deck of the pier and the two-story warehouse shook violently and seemed to sway laterally and vertically 12 or 14 in throughout the first shock, which lasted from 40 to 60 sec. More than half of the pier from the bow of the ship to the shore collapsed and disappeared, leaving only the stringers on a few piles above the water level. From the stern of the ship the center of the pier for a distance of about 300 ft. collapsed and disappeared. The portion of the pier directly adjacent to the ship, on which stood the two-story Customs warehouse, remained standing. The collapse of the pier threw a great many people into the water. A portion of the breakwater encircling the harbor settled from 8 to 10 ft., some of it disappearing.

BUILDINGS COLLAPSE

Immediately our attention was called to the buildings which had collapsed along the water front. The Oriental Palace Hotel, the Grand Hotel, the Standard Oil Building, and other buildings along the Bund had fallen and it was apparent that most of the structures throughout the city had collapsed. As the buildings in the city collapsed a great cloud of dust arose from the wreckage and obscured a clear vision of the shore. The people on the portion of the pier which had not collapsed sought shelter by finding their way over the wrecked portion of the pier to the shore. Others sought shelter on the steamships *Steel Navigator* and *Andre Lebon*. As soon as our gangway openings could be unfastened ladders were sent down the side of the ship to take on board the few persons remaining on the pier. This was about 12:05 p.m. During this interval a number of other serious shocks occurred and, the dust cloud having lifted, it could be seen that the city was on fire in many localities. The tug left the side of the ship and the wind rose to a hurricane, blowing from the shore a few points off our port bow at a velocity of 60 to 70 miles an hour, making it impossible to turn the ship from the pier.

In the meantime the fires on shore united to make a complete chain of fire around the city and, fanned by the gale, swept towards the water front. At 12:30 p.m. the whole city was on fire and the heat coming over the ship was so great that the fire hose, which had been manned, were played over the decks of the ship. Two oil tanks on the ship's launch were thrown overboard. From this time the heat was intense and a large quantity of burning mate-

Automobile Association Plans to Broadcast Road Information

The national headquarters of the American Automobile Association in co-operation with the Radio Corporation of America will broadcast the latest information on road conditions every Wednesday night at 8 o'clock, Eastern Standard time, from Station WRC at Washington, D. C., which station has an effective consistent radius of 500 miles. While attention will be given to road and touring conditions based on data supplied by the National Touring Bureau, accident prevention, handling traffic, road building and maintenance will be discussed by recognized national authorities. Information of sufficient importance for use in this way may be sent to the American Automobile Association.

rial and cinders fell on the decks, and many of the small boats, lighters, junks, etc., all over the harbor, were set afire and, as their mooring lines burnt, drifted among the ships.

1 O'clock—The heat was so intense that the fire service was barely adequate to keep the exposed surface of the ship wet down. In addition to this, the force of the wind driving the heat and cinders and other debris into the faces of those operating the hose was at times blinding and it required relays of men at short intervals in order to keep the ship properly protected. Before this time it was quite evident that no one on shore could have survived the heat who had not escaped from the city prior to the joining together of the fires. Many had been forced by the heat into the water and could be seen floating around the bay in great numbers on timbers and other wreckage. The wind was so great that it was impossible to lower any life boats, and besides, every man aboard was fighting to his utmost to save the ship from fire. Those steamers which were able to get away from the piers and inner anchorages left for the outer bay. A small Japanese freighter drifted against the *Empress* but, fortunately, did no serious damage.

The *Steel Navigator*, which was lying directly astern of us and whose captain was ashore and subsequently found to have been killed, dropped one of her anchors immediately after the first shock of the earthquake and as the gale increased dropped her second anchor.

2:30 O'clock—It being apparent that, due to burning material carried by the wind and the intensity of the heat from the shore, the two-story Customs warehouse, which stood on the pier immediately adjacent to the ship, would take fire, and on account of the closeness of this warehouse, a matter of some 20 or 30 ft., the *Empress* tried to back away from this portion of the pier and in so doing the anchor chain of the *Steel Navigator* fouled her port propeller. This left the port propeller and engine useless, and in addition to this the chain was so engaged with the propeller that it acted as an anchor astern. By this time the Customs warehouse was afire and it was only the energy and courage of the officers and crew that saved our ship from taking fire until the shed had collapsed and the flames had somewhat subsided. At 4:30 o'clock the wind changed direction slightly and lessened in velocity. Innumerable burning small craft were drifting around and against the *Empress* and the danger of fire from this source continued very critical.

5 O'clock—The worst of the fire hazard was over and the wind had sufficiently subsided to permit several ship's boats to be lowered and sent to the shore for rescue work. The shore fires continued to rage all around the bay as far as one could see and many of the larger warehouses and buildings which had resisted the early ravages of the fire now burnt fiercely. The refugees commenced to arrive on the ship, many of them suffering from injuries and practically all of them from eye trouble caused by the heat and smoke. None of them had any but the clothes they stood in, and in most cases these were very few as they had used their clothes to wrap around their heads to protect them from the heat and smoke. At midnight the fires were still raging and could be seen all over the sky-line. Barges were burning in the harbor and many of the large fuel oil storage tanks were afire and exploding.

Oil in Harbor Burns

On Sunday morning most of the fires on shore were dying down but the surface of the harbor was covered with large pools of oil which had escaped from the exploding tanks. This oil was burning at various points, the largest fire, however, being directly against the shore in front of the Bund and about half a mile from the ship. This fire traveled along the shore until it reached the wrecked pier and commenced to follow the line of the pier out towards the ship. The flame of burning oil was at least 300 ft. in diameter and 150 to 200 ft. high. It became apparent, from the accumulation of oil around the ship and in many pools on the surface of the harbor, that with the approach of the fire from the shore the ship would have to move immediately. As the port propeller was out of commission and it was hazardous to try to operate the starboard engine for fear of also fouling it in the same anchor chain, the captain of the *Empress* requested the *Steel Navigator* to tow us back clear of the wharf, which was done. When we were some 200 ft. clear of the end of the pier anchor was dropped to avoid collision with nearby ships, and the engines were tested to ascertain whether or not they could be used. It was found that the port propeller could not be used but that the starboard propeller was clear.

As the ship lay in a pool of oil and the fire was still rapidly approaching along the line of the pier, and it was practically impossible to navigate through the number of ships lying at anchor in the harbor, the captain proceeded forward and by skillful manouvering directed the ship from the danger zone through the entrance of the inner harbor, and anchored nearby. Unquestionably the anchor fastened to the anchor chain which had fouled our port propeller had broken loose or lifted clear of the harbor bottom. Otherwise, this manouver would have been impossible. At 7 o'clock Sunday evening the oil had drifted out from the inner harbor and was again collecting around the ship. The tides and currents were in such a direction that it was dangerous for a crippled ship of the size of this one to attempt to move without assistance and an oil tanker in the harbor aided the *Empress* to turn about and reach water considerably beyond the oil pools. From that time the *Empress of Australia* was not in serious danger.

During all of Sunday the refugees continued to arrive on the *Empress* and to be received irrespective of condition, class, or nationality. There were probably 1,500 refugees on board. Many of these were seriously injured and practically without clothing, and it was impossible to move about the ship without encountering numerous cases requiring attention. It is remarkable the efficient service which the doctor and his staff rendered, not only to those slightly injured, but to many refugees with major injuries which required his personal attention. A number of volunteers ably assisted the doctor and his staff and did very efficient first aid work. The manner in which the officers and personnel of the ship received, cared for and fed the refugees is beyond commendation.

Reclamation Commission to Meet Oct. 15

First Session of Fact Finding Body Announced—Members Tell Work of Willingness to Act

A meeting of the fact-finding commission appointed recently to investigate conditions under which work in the Reclamation Service is prosecuted has been called by Secretary Work for Oct. 15. This will be the first gathering of the commission. Though seven nationally prominent men were first invited to become members of this commission, one, Elwood Mead, of California, is out of the country, and therefore will be unable to serve. The others who last week notified Secretary Work of their acceptance of his invitation to act are Julius H. Barnes, president of the U. S. Chamber of Commerce; Oscar E. Bradfute, president of the American Farm Bureau Federation; Thomas E. Campbell, former governor of Arizona; Dr. John A. Widtsoe, former president of the state university and the state agricultural college of Utah; and David W. Davis, former governor of Idaho and present commissioner of the Reclamation Service. James R. Garfield, who has but recently returned to this country, has been notified of the meeting Oct. 15, though he has not yet formally accepted Dr. Work's invitation to serve on the commission. Another member of the commission added during the week is Clyde C. Dawson, authority on irrigation law.

Secretary Work advised the members of the new commission that every facility at the disposal of the Department of the Interior would be placed absolutely at their service; that he wished every phase of the situation gone into thoroughly, and that he would appreciate a blunt and unvarnished report of conditions precisely as they may be found to exist, whether good or bad.

Public Will Get Facts

The Secretary explained further that when the report of this commission is completed he shall present it in toto to the President, Congress and the public.

The commission is asked to ascertain the whole amount of money expended by the Government and returned to it; the total sum owing but not due, and the amount due but unpaid; the relation between estimates and final costs; between expenditures and returns represented by structures, and to suggest the best approved methods of accounting, if not already practiced; the construction costs and methods employed to get water to the land; the methods of application of water in agriculture; original estimated costs of projects with actual costs; estimated time necessary for completion with actual time intervening; number of acres proposed to irrigate with actual number under irrigation; estimated costs per acre to water users before the work was begun and the actual cost when completed; whether the service lent itself to promotion or sought to determine possibilities and requirements of the locality; whether the government has obligated buyers of water to a higher acre cost than first proposed; if rates charged are impossible of payment from the land; if the government service is adequate; if the government has kept faith with the settlers by fulfilling its obligations for water supply; and if delinquencies have been unavoidable.

Grant Smith Dies

Was Head of One of Country's Largest Construction Companies—Activities of Organization Nation-Wide

Grant Smith, founder of the contracting firm of Grant Smith & Co. an organization which grew from a single small St. Paul firm to a group of associated companies operating all through the United States and Canada, died in St. Paul last week suddenly of heart trouble. He had just returned from a visit to his New York office the day before he died. He was 59 years of age at the time of his death.

Mr. Smith was born in Portage, Wis., in 1864. At an early age he entered contracting work and while still in his early twenties formed an association with E. V. and W. E. Hauser, both of St. Paul, the firm name becoming and remaining Grant Smith & Co. One of the first jobs taken by the firm was a subcontract on the construction of the Chicago Drainage Canal. The firm later took on numerous larger contracts, among the projects being revision of the shore line of the Great Northern Ry. into Seattle, and considerable municipal work for Seattle and Milwaukee. Activity of the organization in the Northwest became conspicuous between 1906 and 1910 when Grant Smith & Co. had a 70-mile contract on the construction of the Spokane, Portland and Seattle Ry., a Hill enterprise, and several contracts for the Canadian Northern and the Canadian Pacific Rys.

New York Firm Established

In 1911 Grant Smith & Co. & Locher was established in New York. This firm held contracts on the construction of the Catskill Aqueduct, the New York Barge Canal and two large rock contracts for the government in the Soo and Detroit Rivers. This company built that part of the aqueduct from 14th St. to 106th St., Manhattan. The name of this branch of the firm was changed in 1914 to Smith, Hauser & MacIsaac, a firm which has been active in river and harbor work in and near New York City since its inception. Smith, Hauser & MacIsaac also built during the war Camp Meade, the Curtis Bay Ordnance Depot at Baltimore, and the Ben Franklin Signal School.

During the war Grant Smith & Co. built the first wooden ships for the government in yards on the Pacific Coast at St. Johns, Ore., and at Grays Harbor, Wash. The original contract called for the construction of 50 of these vessels, most of which were built before the armistice cancelled contracts on half a dozen or so.

About twelve years ago Mr. Smith formed a Canadian branch known as Grant Smith & Co. & McDonnell. Headquarters were in Vancouver, and the activities of the company extended all through Canada, the company at the present time having charge of the construction of the extension into James Bay of the Timiskaming & Northern Ontario Ry.

Heavy Rains Destroy Trestle, Wrecking Burlington Train

The washout of a 110-ft. timber trestle spanning Cole Creek adjacent to its confluence with the Platte River near Casper, Wyoming, was responsible for the wreck of a Burlington train Sept. 28 in which about two score lives were lost. Heavy rains falling continuously during the 24 hours prior to the wreck had swollen the creek, which usually has a dry bed, into a raging torrent. A freight train had passed over the trestle but two hours before the wreck, and the roadmaster, on the train, had reported that there was no evidence of weakness in the trestle. A trackwalker had reported the structure safe an hour after the freight passed.

The locomotive and four cars were thrown into the water and the cars were either washed downstream or buried in the debris and sand. More than a score of passengers were rescued from the roof of a partly-submerged sleeping car by means of a rope suspended in midair from the car to the shore. About 80 passengers were said to have been on the train.

Civil Engineers to Have Earthquake Committee

The president of the American Society of Civil Engineers has been authorized by the Board of Direction to appoint a committee to collect information on the effect of earthquakes on structures. This is a result of the Japanese disaster. The appointment of the committee is the result of a letter by Col. John Millis, Corps of Engineers, U. S. A., to President Loweth calling attention to the great amount of information which would doubtless result from the Japanese earthquake and the necessity for collecting and collating that information for the benefit of future designers. A meeting of several of the members of the society was called with the representatives of the other national engineering societies, as a result of which a resolution was adopted recommending that the American Society of Civil Engineers undertake this study with such co-operation of the other national societies and the national societies of other nations as could be given.

President Loweth has not yet selected the personnel of the committee for this special study.

Birdseye Party Escapes Colorado Flood

Fear for the safety of the U. S. Geological Survey party headed by Col. C. H. Birdseye now making a trip down the Colorado River was set at rest by direct news received Oct. 2, from Peach Springs, Arizona. The party emerged from the flood-swept Grand Canyon, escaping by climbing through a crevice to high ground. From a safe eminence they saw the flood wall of water sweep the canyon. Noticeable rise in the Colorado's flow warned the party of impending danger in plenty of time to escape to high ground. There are ten members in the party.

Random Lines

Rubbing It In

A week or so ago a New York contractor went all the way out to Denver to close a contract he thought he was going to get for the construction of the Moffat tunnel. They treated him pretty rough in the high country. Not only did they award the contract to another fellow nearer home but on the way to his hotel a footpad held him up and took $200, a diamond ring and his watch away from him.

* * *

Building a La Mode

Sir—Some years ago I saw in your building a very wonderful train of automatic machinery assemble the magazine—I have occasion to use a similar train to assemble the parts of a building, and it occurs to me you might be able to put me on the right track, as to whom I should apply.

I have just been to the Aeolian Co. and they agree to make me a controller, similar to that on the player pianos. I intend to take an architect's plan, enlarge it to full size, by photostat, mark on it every pipe, heating and ventilation duct, electric conduit, etc., accurately, cut it in strips, suitable to pass through their controller, punch holes in it, similar to those now in use on the music rolls. Corresponding to these holes will be a series of pipes or rubber hose, these pipes will connect with the various machines, which do the particular thing required by the hole in the plan.

By pumping air, or by suction of vacuum, we can move or stop the rheostats, which shoot the juice, into the motors of our various machines.

What I want is to meet manufacturers of automatic machines, suitable for my purpose. I can see no reason why I cannot equip a factory, and turn out sections, which will clamp together, just as the sections of a bookcase do; except that my sections will only be of such size, as would fit in a box car, as I would have to ship them, to their destination complete.

Do you think it would be possible to arrange with your company to have an article published, describing this process? I desire to get the general opinion of the engineering profession, to pass on this, which I believe is a method whereby 75 per cent of the cost, and 90 per cent of the time, now consumed in building, can be saved. I have interviewed numberless architects, builders, and manufacturers of building material, and I have yet failed to meet a single man who did not commend my purpose: that there is disagreement as to the best method of attaining it, is of course to be expected. I would therefore like to put the problem squarely before the American public, and see whether or no they care sufficiently for their so-called liberties, to back up a 100 per cent American revolution, against the menace of oligarchy.

J. A. H.

This highly practical scheme, submitted in all seriousness, is herewith placed before the engineering profession for opinion.

Railroads to Co-operate With Port Authority

Belt Line on the New Jersey Side of New York Harbor to Be Set Up by Trunk Railroads

The immediate outcome of the concurrent hearings before the Port of New York Authority and the Interstate Commerce Commission held during the week of Sept. 17 is that the carriers' operating committee and the engineering staff of the Port Authority are now working together to determine what improvements in operation of the marginal railroads in New Jersey can be effected at once through physical and operating changes along the lines proposed by either or both parties. As soon as this first step in the improvement of port facilities is well under way, similar co-operative studies will be made to determine the exact location of the middle belt line west of Bergen Hills in New Jersey, which line the carriers now agree should be completed as promptly as possible.

MARGINAL RAILROAD

The marginal railroad in question, known as Belt Line No. 13 of the Port Authority's comprehensive plan, is made up of sections of track of the various railroads along the west side of the Hudson River at New York and extends from Fort Lee on the north, to Constable Hook near Staten Island on the south. The sections of track which make it up are now operated by the various railroads more or less independently, but during the war they were operated as a belt line and the Port Authority, as the first step in putting its so-called Comprehensive Plan for the development of the Port of New York into effect, called upon the railroads to set up this belt line again and arrange for its unified operation. Opposition to this plan, on the part of the railroads, resulted in two hearings before the Port Authority and the Interstate Commerce Commission sitting concurrently, at which times the railroads were called upon to show cause why this belt line should not now be put into effect. The interval between the two hearings was provided in order that the railroads might have time to prepare their arguments after hearing the case as presented by the Port Authority. But instead of coming forward at the September hearing with arguments against the proposed belt line, the railroads came forward with a resolution signed by fourteen officials of the principal railways affected, in which they stated that they were of the opinion that no consolidation of existing tracks into a belt line nor their unified operation was necessary at this time, and that the existing facilities were ample to handle the current traffic and any normal increase, but that facilities at interchange points should be provided in order to insure economical and expeditious handling of traffic. These facilities included increasing the capacity of the West Shore R.R. yard at Kings Bluff, certain interchange tracks and crossovers, interlocking devices and automatic signals, an estimated cost of about $500,000. In addition to this, the presidents of the three railroads principally affected agreed to appoint a supervisory operating agent to direct the movement to, from, and over their joint lines. The railroad companies also presented a second resolution to the effect that all interested railroads join in having a study made for the construction of a belt line on the west side of Bergen Hills and east of the Hackensack River for the interchange of freight.

The proposal of the railroad companies in so far as physical changes are concerned agrees substantially with the Port Authority's plan, under which it estimates that the operation of belt line No. 13 as a belt line will result in an annual saving of about $1,100,000. The operating arrangement proposed is not complete unification as proposed by the Port Authority, but is expected to give practically the same results without the legal complications necessary to effect unification and it can be modified at any time that the Interstate Commerce Commission feels that shippers are not getting the full service they would get under unified operation.

The portion of the middle belt line No. 1 which the railroads propose to set up is practically all in existence, with the exception of four miles of extensive trackwork at the north end. Its primary function is to divert through business and interchange business away from the congested yard around the water front. The railroad companies consider it much more essential than belt line No. 13 and have been considering ways and means of building it for a number of years. The recent hearing made it possible for them to bring forward the proposition in order to discuss the details and method of construction with the Port Authority. In regard to financing the necessary improvements, the counsel for the Port Authority said that the Port Authority stands ready to use the power vested in it as a Port Authority to acquire any additional land, equipment, facilities, or anything else that may be needed for the operation of this or any other part of the Comprehensive Plan, and are prepared to borrow the money necessary to effectuate the same upon the rates of interest the tax exempt securities will bear in the market; that it stands ready at any time that such action becomes desirable to become the operating agency of either belt line No. 13 or any other part of the Comprehensive Plan.

Greene Starts Investigation of N. Y. Barge Canal Bureau

Investigation of the New York State Department of Public Works under the superintendence of Edward S. Walsh, present commissioner of canals and waterways under the reorganized Department of Public Works, was begun Oct. 2 by Supreme Court Justice Joseph A. Kellogg acting as a special commissioner. The hearing into the administration of the canal bureau was directed by Governor Smith at the instance of Col. Frederick Stuart Greene, present superintendent of the State Department of Public Works, following charges made by Col. Greene that $70,000 paid for supplies bought from the General Mill & Contractors' Supply Co., of Albany, was $25,000 in excess of alleged market quotations. During the first day's inquiry Col. Greene submitted numerous receipted vouchers for supplies, each one of which he maintained was far in excess of a reasonable market quotation.

Ramapo Water Project of City of Bayonne Upset

The New Jersey Court of Errors and Appeals has ruled that the City of Bayonne cannot take water from the Ramapo River for its supply because it failed to get the consent of the North Jersey District Water Supply Commission before applying to the State Board of Conservation and Development for a water right permit. In addition, the court holds the permit from the Conservation Board to be of no force because of certain technical defects in the proceedings. The Bayonne application was filed in 1921, and the permit was granted on March 23, 1922 (see *Engineering News-Record*, March 30, 1922, p. 511). The permit allowed Bayonne to divert 50 m.g.d. from the Ramapo River and continued various requirements as to supplying water to other communities and developing a larger supply, if demanded.

Some of the opponents of the Bayonne project held that notwithstanding the provisions to safeguard other communities inserted in the permit by the Conservation Board the grant violated that water policy of the State as embodied in legislation creating the North Jersey Water Supply District and providing that no municipality in the district should be allowed to acquire rights in any new source of water supply without the approval of the District Commission.

Bayonne maintained (1) that certain home rule legislation enacted after the district was created freed it from the jurisdiction of the District Board and (2) that since it now gets water from the Passaic River (by contract) and since the Ramapo is a "branch" of the Passaic therefore the Ramapo would not be a new source of supply. The State Supreme Court upheld contention (1) but the Court of Errors and Appeals reversed that decision and disallowed (2) as well. As to the second point, the highest court held that a "branch" is a part of a parent stream while a tributary has a drainage area of its own until it discharges into some other stream or body of water, after which the waters of the tributary become a part of the stream so joined. Consequently, the Ramapo River would be a new source of supply for Bayonne.

The suit in question was brought by the Borough of Oakland and other municipalities in the Ramapo drainage area. Since the city authorities of Bayonne voted to take steps to get a water supply from the Ramapo, there has been a city election which resulted in a majority of the City Commission or Council adverse to the Ramapo project.

To Raise Endowment for Stevens Institute

The Stevens Institute of Technology million dollar endowment campaign was given impetus at a meeting held Sept. 27 at the Engineers' Club under the direction of John W. Lieb, vice-president of the New York Edison Co., who is in charge of the campaign in Manhattan, New York City. Plans for raising the New York quota for the fund were perfected following an address by Alfred R. Whitney, Jr., of the Whitney Co., who is a member of the national executive committee for the fund.

A. P. Davis Made Chief Engineer of East Bay District

Arthur P. Davis, late director U. S. Reclamation Service, has been appointed chief engineer, and Gen. George W. Goethals, of New York City, and William Mulholland, of Los Angeles, consulting engineers, of the East Bay Municipal Utility District, comprising municipalities across the bay from San San Francisco. The first objective of the district is to purchase the existing privately owned water-works serving that territory, and the next is to construct additional supply works. As sources of supply there have been suggested for choice the Sacramento, McCloud, Yuba, American, and Eel Rivers; also partnership with San Francisco in the Hetch Hetchy supply.

At a meeting of the directors of the district on Sept. 20, it was voted to have Mr. Davis report on whether a lack of water or its improper distribution contributed to the great fire in Berkeley on Sept. 17.

Bids Rejected for Perth Amboy Raritan River Bridge

The New Jersey State Highway Commission has rejected all the bids for the new bridge over the Raritan River at Perth Amboy as being too high. The lowest bid was about $600,000 in excess of the highway department's estimate; it was the bid of the Frederick Snare Corp. of New York for a total of $3,934,000. The same corporation submitted a bid of $3,890,000 for the bridge without trolley tracks or power conveyors and of $3,872,000, omitting asphalt block pavement. Other bids submitted on a similar basis were The Stillman, Delahanty Ferris Co. of Jersey City, $4,444,696 and $4,329,696; and Patrick McGovern, Inc., New York, $4,933,011 and $4,793,011. It is expected that the bids will be re-advertised some time in December and it is possible that the designing engineer, Clarence W. Hudson, will suggest some changes to be made in the design in order to bring the cost more nearly to the amount of the original estimate.

Voters Approve Philadelphia Transit Plans

Approval was given on Sept. 18, at the time of the primary elections in Philadelphia, to a transit referendum bill transferring previously appropriated funds from the purposes for which they had been voted, to construction of subway lines in accordance with the plans recently approved by City Council. The referendum was carried by a majority of 151,500 votes. It releases about $48,000,000.

The funds had formerly been "earmarked" for certain lines, but they were not sufficient in any case to complete the lines contemplated. The transfer approved last week makes the money available for Step No. 1 in the comprehensive transit plans recently developed by a Councilmanic Transit Commission, as described in *Engineering News-Record*, Aug. 2, 1923, p. 196.

As the funds thus made available will not be sufficient to complete the work of Step. No. 1, additional funds are expected to be included in a new loan bill to be voted on in November.

Calendar

Annual Meetings

AMERICAN PUBLIC HEALTH ASSOCIATION, New York; Annual Meeting, Boston, Oct. 8-11.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Fall Meeting, Richmond, Va., Oct. 17-20.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Petersburg, Fla.; Annual Convention, Atlanta, Ga., Nov. 12-16.

CITY MANAGERS ASSOCIATION, Lawrence, Kansas; Annual Meeting, Washington, D. C., Nov. 13-15.

AMERICAN ROADBUILDERS' ASSOCIATION, New York City; Annual Convention, Chicago, Jan. 14-18.

American Water Works Association, New York Section, will hold its first meeting for 1923-4 at Watertown, N. Y., Saturday, Oct. 6.

The Engineers' Society of St. Paul will celebrate on Oct. 8 the fortieth anniversary of its founding. Charles F. Loweth, president of the American Society of Civil Engineers and a charter member of the St. Paul society, will give the principal address. The first meeting of the fall season, Sept. 10, was addressed by Col. Frederick Mears, chief engineer of the St. Paul Union Depot Co., on "Alaska Railways," of which he was formerly chief engineer. On the same day the society resumed its noonday luncheons, being addressed by B. M. Cowan and W. F. Brown, chief engineer and assistant chief, respectively, of the new Ford plant at St. Paul.

Personal Notes

JAMES H. FUERTES has been retained by the Board of Water Commissioners of Denver, Colo., to act in an advisory capacity and to assist the engineers of the board in preparing plans and specifications for the city water improvement under the $6,500,000 water bond issue authorized in the last city election.

C. A. BAUGHMAN, who spent the summer with the Iowa State Highway Commission investigating the comparative value of concrete pavements of various kinds in order to aid in preparing specifications for hard-surface roads, has now returned to his work as professor of highway engineering in Alabama Polytechnic Institute, Auburn, Ala.

SAMUEL REA, president of the Pennsylvania R. R., celebrated on Sept. 21 the 52nd anniversary of his connection with the railroad, his services having started in the position of chainman. He has been president of the lines since 1912.

CLYDE A. WALB, whose term as vice-chairman of the Indiana board for the registration of professional engineers and land surveyors will end about the first of next year, has resigned.

HON. FRANK OLIVER, of Edmonton, Alta., formerly Canadian Minister of the Interior, has been appointed a member of the Dominion Board of Railway Commissioners, succeeding the late Dr. James G. Rutherford.

GEORGE GUY, former engineer of the public utilities commission of Winnipeg, has been made managing director of the Tudhope-Anderson Co. of Onillia, Ont.

H. G. BAYLES, Morgantown, W. Va., has been chosen city manager, succeeding Arthur A. Hall, resigned, who returns to his former employment as professor of electrical engineering at West Virginia University, Morgantown.

THE MCKELVEY CONSTRUCTION CO., St. Louis, Mo., has opened a branch office at 320 St. Charles St., New Orleans, La., with B. H. Alvey in charge. Recently this company opened a branch in Detroit.

C. L. HUGGINS, city engineer of Berkeley, Calif., has tendered his resignation, effective Oct. 1.

R. P. KITE, of the Dorr Co., engineers, has been transferred from the New York office to the Chicago branch, where he will work with J. V. Slade.

L. E. ANDREWS has been appointed division construction engineer with the New Jersey State Highway Commission, in charge of the Northern Division, with headquarters in Newark. Mr. Andrews was formerly survey engineer in the Southern Division, and previous to that was assistant district engineer with the Pennsylvania State Highway Department; engineer officer on road construction in France and resident engineer with the Illinois State Highway Department.

C. A. BURN, of Caldwell, N. J., will have direct supervision of highway construction in New Jersey for the Public Service Production Co., of Newark. Mr. Burn was formerly Northern Division construction engineer with the New Jersey State Highway Commission.

V. BERNARD SIEMS, who has been assistant water engineer at Baltimore, Md., has been appointed water engineer. Re-appointments, also, are: STEUART PURCELL, chief engineer; BERNARD L. CROZIER, highways engineer; and BANCROFT HILL, harbor engineer.

COL. WILLIAM KELLY, the chief engineer of the Federal Power Commission, is making a detailed inspection trip throughout the Rocky Mountain region. He expects to visit a considerable number of projects. During Col. Kelly's absence, Major H. S. Bennion will act as chief engineer for the commission.

ED. O. MCMAHON, formerly assistant engineer with Howard McCurdy, Los Angeles, Calif., is now located at Santa Ana, Calif., in charge of field work for Hoy & McMahon, civil engineers.

L. J. FELLOWS, formerly assistant engineer for the Longbell Lumber Co. on street paving at Longview, Wash., is now engineer in charge of construction of a power plant at Longview, for Charles C. Moore & Co., engineers.

COL. CHARLES KELLER, of the Corps of Engineers, has been retired from active duty in the Army after more than thirty-seven years of service. The action was taken at the request of Col. Keller. It means that Col. Keller has definitely cast his lot with the hydro-electric industry. Col. Keller was made manager of the El Dorado project being developed by the Western States Gas & Electric Co. in the Sierras near Placerville, Calif. He was granted a leave of absence in April, when he resigned as engineer commissioner of the District of Columbia.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Time Saved for Buyer of Supplies by Organized Sales Methods

Assignment and Follow-Up of Prospects Prevents Needless Calls and Disputes About Commissions

By Albert H. Rhett
Summit, N. J.

INTERVIEWS with salesmen of construction equipment and materials are often regarded by contractors, engineers and architects responsible for purchasing or recommending the purchase of machinery and supplies, as a necessary, but onerous and time-consuming part of their duties. The selling of building supplies and contractor's plant presents some of the most difficult problems in the whole field of merchandising, yet seldom does the user of equipment consider this problem of selling from the point of view of the manufacturer. The peculiar feature about selling in the construction industry is that in almost every case *two* individuals with somewhat divergent interests have to be "sold." It is difficult enough to sell one thing to an individual who needs it, but more than twice as hard to sell the same thing to two individuals who do not, very often, want the same thing.

These two people are the engineer or architect and the contractor. Their divergence of interest arises from the fact that the engineer or architect, being responsible for results, desires the best he can get, while the contractor, at least on the usual lump-sum form of contract, desires—and this is said with apologies where due—the cheapest. The question of personal friendship or favoritism also enters doubly. The sales problem, therefore, is to synchronize these interests into orders on as many building and construction operations as possible.

One Manufacturer's Methods

It is proposed to show below the method used in the case of a manufacturer in New York City producing a varied line of specialties sold throughout the country. The method has two phases pertaining to local and national distribution, of which the local phase will be considered first. In the greater metropolitan district there are nearly a thousand architects; from 3,000 to 4,000 projects have to be followed for various materials each year. Competition is keen; prospects most difficult to see; and only the most direct and efficient sales methods will produce satisfactory results. The multi-phase nature of the sales effort to be made affects every detail of the sales management problem—assignment of work to the salesmen, method of follow up, even method of compensation.

All construction projects begin in the office of the engineer or architect and as it is desirable, if not always necessary, to have specifications that will cover the supplies or equipment to be distributed, the sales effort must begin at this point. Each project is bid on by many contractors from various localities and one contractor may have contracts from the offices of several engineers or architects. In this fact arises the first difficulty, the method of assignment of work to the salesmen.

It would be desirable to have but one salesman of the same manufacturer call at the office of each engineer and each contractor and an attempt to do this has been made by having specially trained salaried men do the preliminary work in the engineer's office and commission salesmen do the actual selling in the contractor's office. The inevitable result, however, is loss of continuity, duplication of effort and credit disputes. A territorial method of assignment is also, obviously, out of the question, because the engineer or architect may be located in one district, the contractor in another, the job in another, the owner in another—and all may have to be followed up.

Plan of Assignment

In the instance under consideration the plan of assignment used was based on the theory that the sales effort must begin with the engineer or architect at the specification stage and the man beginning it is the man to follow it through to its consummation. Consequently, the offices of all engineers and architects in the district were arbitrarily divided among the various salesmen. Each man was allowed to call only on the offices assigned to him, and was held responsible for results or lack of results obtained on all projects emanating from these offices.

This plan produced the desirable result of having but one man call on each engineer or architect but was open to the objection that various salesmen did call on the same contractor on various projects. It was thought that this objection was more than offset by the fact that but one salesman had to familiarize himself with each project and he alone handled all the negotiations with the various parties concerned on each operation.

It might be anticipated that with several men calling at a contractor's office, poaching and commission or credit disputes would inevitably result, but this was obviated by a simple card record system which also provided an almost automatic follow-up index.

Card Record System

Advance information of all proposed operations was received from one of the agencies providing this service.

No	Prospect	Date Added	Salesman	Architect	Contractor	Specs.	Quotations Prop.	Quotations Fin.	Sale Mat.	Sale Amt.	Calls
4151	Office Building 16 stories & basement 8th Ave.& 47th St. Brick. Steel Frm. fl. $3,000,000.-	7-15	Sharp	McBride & White.	Miller & Johnson						7/17 8/3 8/15,16 9/1
4152	Apartment Bldg. 12 stories & basement 86th St & Lex. Ave. $1,500,000.	7-15	Jones	A.B.Alexander.	J.C. Brown,Inc.						7/16 7/27 8/1
4153	School,- 4 stories. Brick. Fireproof. 180th St.	7-15	Black	R.C.Camp. &	Reed &						

FIG. 1

Location 8th Ave & 47th St.
Number 4151
Architect McBride & White
Contractor Miller & Johnson
Description Office Bldg.- 16 stories.- $3,000,000.

FIG. 2

Name McBRIDE & WHITE. Salesman Sharp

Number	Date	Description	Specified	Remarks
4151	7-15	Office Bldg. 16 stories. 8th Ave., & 47th St. Brick & Steel.$3,000,000.		
4314	9-7	Hotel. 15 stories. 91st St. & Bdwy. $2,500,000.-		

FIG. 3

Distributor ADAMS & PAYNE Location CLEVELAND, O.

No.	Date	Proposed Work	Contracts Let	Specif.	Sales	Remarks
115	6-8	Theatre & Office Bldg 10 Stories.-$1,300,000 Archt.-F.W.Ballin	J.W.Green. 12-1-22.			
116	7-8	School.- Euclid Ave. $500,000. Archt.- Heath& Heath				Bdlt. and

FIG. 4

FIG. 1, PROSPECT RECORD; FIG. 2, JOB LOCATION CARD; FIG. 3, ARCHITECT'S OFFICE CARD; FIG. 4, LOCAL DEALER'S CARD

Each project was serially numbered, entered on the card (Fig. 1) and referred to the salesman to whom the office of the architect or engineer concerned had been previously assigned and on whom he was expected to call promptly in regard to this specific job. All salesmen made daily reports, referring to each job by serial number. The dates of calls were entered in the right hand column; quotations or sales also were recorded. All orders, however received, were traced to the operation on which they were used and if the record showed that the salesman to whom the operation had originally been referred had properly followed it, his credit was immediately established. On the other hand, if the record showed neglect, he received no credit.

The follow-up was effected by surveying the call column periodically and notifying the salesman involved if any

job failed to show a call date within a reasonable period. It will be observed that each job, when entered on the Prospect Record (Fig. 1), was simply given a serial number and it was necessary to index these numbers with two supplemental index cards, (1) a location card for each job (Fig. 2) filed according to location and giving the serial number, and (2) a card for each architect's office (Fig. 3) filed according to name of architect and giving description and serial numbers of current work in that office.

REASONS FOR INDEXING

There are several reasons for this indexing. If a salesman picked up a job on the outside he was required to register it and get a serial number for it. With the location or architect's name known it could be seen at once from the respective cards whether or not it had been previously assigned or worked, and conflicts and duplication of effort thus are avoided. Conflicts and duplication were also likely to arise from the assignment to the wrong man of the "follow up" on telephone requests for quotations or information on any operation. If the inquirer could give the location of the job or architect's name the serial number could be ascertained from either index card and this reference number on the main card gave the full history of the job and the man working it. It was also desirable to have a complete record of all work in each architect's office. The keeping of this simple three-card system insured the following of every possible prospect, increased the volume of sales and absolutely eliminated credit disputes among the salesmen.

Another factor that had an important bearing on the situation was the method of remuneration of the salesmen. It was found that the salaried men worked the architect's offices very nicely but were not always "there" when it came to the final struggle of closing in the contractor's office. On the other hand, the commission men were always looking for the quick break in the contractor's office and would not do the time-consuming, but essential, work in the offices of the engineers or architects. The salary plus commission method of payment was found to give the most satisfactory results.

NATIONAL DISTRIBUTION

When the question of national distribution is considered matters become still more complicated. Of course if district offices are used the same system could be applied in each office, but only the larger cities can support a district office and there is considerable expense to be carried in the way of office, storage and trucking facilities. There is, however, in almost every town of any size a building supply dealer with these facilities and as the market for the commodities manufactured in this instance was general, this method of distribution was used.

The objection, however, is the same as that encountered in the use of commission men on the local work. The building supply dealer sells the contractor and is usually neither inclined nor equipped to do much work with the architect or engineer. This necessary part of the work had to be otherwise accomplished by dividing the dealers into groups or districts and having a salaried man from the home office cover all the architects and engineers in each district periodically, working with the dealer and selling through him.

This work was given point and intensity through the use of a card record (Fig. 4) somewhat similar to that used locally. This form of card was kept for each dealer. Advance information of the most important projects in each district was obtained from an available source and entered on this card and on two additional copies. One copy went to the dealer with the request that he fill in the information and return. Sometimes he did this and sometimes he did not, but it acted as a prod or reminder. The second copy went to the salesman who covered that district, so that he went to each locality with advance information, at least on the major projects, and did not have to rely on the dealer for information. He reported by number the result of his work on each job and this was entered on the original card. This record was of further use in showing to which dealer should be referred requests for information received through the mail and also in straightening out disputes between dealers which most often arose through the complication of the architect being in one location and the contractor or job in another.

August Paving Brick Shipments

Paving brick shipments for the month of August were higher than for any previous month in 1923, according to statistics just issued by the National Paving Brick Manufacturers Association. Reports from 67 per cent of the industry's tonnage showed that shipments were more than 9,000,000 greater for August than for July, 36,446,000 brick being shipped in August and 27,092,000 in July.

Production for August was 33,457,000 brick as against 30,529,000 for July. Stock on hand the last day of August was 74,399,000 as against 78,835,000 the last day of July. This reduction of 4,000,000 in stock on hand was due to the heavy August shipments.

There was a falling off in unfilled orders amounting to 12,000,000 brick, a natural trend toward the end of the summer paving season.

Ohio led all other states in consumption, 5,781,000 brick going for city streets and 5,784,000 for country highways. Illinois was second with Pennsylvania, Nebraska and Texas following closely.

Form Cinder Concrete Association

The National Cinder Concrete Products Association was formed in Philadelphia recently by manufacturers of the Straub patented cinder concrete building block. The purpose of the Association is to increase the use of cinder concrete products and to engage in research work for the improvement of methods of manufacture.

Francis J. Straub, of New Kensington, Pa., was elected president. The other officers are: first vice-president, Raymond M. Weeks, Philadelphia; second vice-president, Henry Boettcher, Lancaster, Pa.; secretary, J. Edwin Rutter, (Cameron and Reily Sts.), Harrisburg, Pa.; treasurer G. Edgar Allen, New York.

Only corporations and individuals holding licenses from Crozier-Straub, Inc., New York, are eligible for membership.

Business Notes

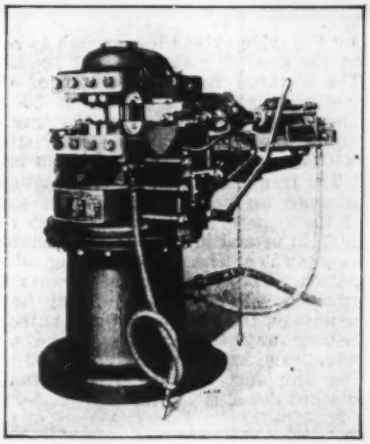
L. W. KEMP, superintendent of the Southwest division asphalt sales department Texas Co. at Houston, Texas, has been appointed manager of the Texas Rock Asphalt Co., San Antonio. Mr. Kemp is a graduate of the University of Texas. He is succeeded by Col. A. D. Stivers, formerly the Texas Co.'s representative in Dallas.

HENRY SEIBEL, president of the Seibel Air Spring Co., San Francisco, manufacturer of shock-absorbing seats for industrial and farming equipment and motor trucks, was the guest of honor at a dinner tendered him by friends on the occasion of his seventieth birthday, Aug. 29, at the Hotel Whitcomb, San Francisco. Col. Charles A. Simmons, manager of the local Chamber of Commerce was toastmaster.

Equipment and Materials

New Shank and Bit Punch

For punching holes when shanking and bitting hollow drill steel ranging in diameter from ¾ to 1¼ in., the Ingersoll-Rand Co., New York, has developed a new type of machine known as the "IRLP" shank and bit punch. It is made in two models, one constituting a part of the company's sharpener and the other a separate unit. The attached-to-sharpener pattern can be attached to the No. 4, 5 and 50 sharpener. The pedestal pattern is a self-contained



DRILL SHARPENER WITH SHANK AND BIT PUNCH ATTACHMENT AT RIGHT

machine with pneumatic clamp, mounted on its own substantial cast-iron pedestal base.

The entire punch is under single-lever control. By holding this hand lever forward compressed air is admitted to a hammer cylinder and by a series of rapid blows the hammer cylinder with punching pin attached is moved forward, thus punching a hole in the drill steel shank or bit which is held in position by a clamping device. To remove the pin from the drill steel it is only necessary to release the hand lever. Springs attached to this lever return it to its normal position, whereby air is admitted to the opposite end of the

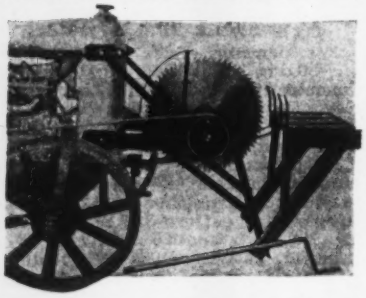
hammer cylinder and the pin is withdrawn by a series of hammer blows. The centering device assures holes which are centrally located and, according to the manufacturer, eliminates the chief cause for breaking water tubes.

The clamping of the steel for the attached-to-sharpener pattern is done by the sharpener crosshead; with the IR-50 sharpener the clamping pressure is 14½ tons at the 100 lb. air pressure. In the pedestal type the clamping jaws are operated through a toggle arrangement and the clamping pressure is much greater than will ever be required.

The attached-to-sharpener pattern weighs 227 lb. No extra floor space is needed for this type. The pedestal type weighs 610 lb. and requires a floor space of 2½ x 4½ ft.

Saw Frame Attachment for Tractor

For attachment to a Fordson tractor, the Stover Manufacturing & Engine Co., Freeport, Ill., has placed on the market a saw frame. Except for the sawing table, the frame is of all-steel construction. Angle steel braces carry-



ing the table extend low enough to rest on the ground, making a stiff support. The distance from the center of the saw mandrel to the ground is 30 in. The drive is by belt from the tractor engine and the frame has an adjusting bolt each side to take up slack in belt.

The frame is carried on four castings attached to the upper and lower ends of the radiator by four bolts that run in front of and in back of the radiator, as shown in the accompanying illustration. The frame, therefore, may be attached without disturbing any bolts or nuts on the tractor and also without drilling any special holes. The circular saw has a diameter of 30 in. The shipping weight of the frame, knocked down, is 250 lb.

Publications from the Construction Industry

Centrifugal Pumps—ERIE PUMP & ENGINE CO., Medina, N. Y., describes in a 23-p. illustrated bulletin its double-suction, horizontally split shell centrifugal pumps for water-works and industrial service, including the handling of ammonia water, brine and hot water. The pumps are built in a variety of sizes with discharge diameters from 2 to 20 in. and capacities of 150 to 14,000 gal. per minute. For handling brine an all-iron type of design is employed, while for service with chemicals pump casings are furnished in acid-resisting bronze.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for, in Construction News, pp. 187 to 200, are the following:

Loft, New York, N. Y., Rathmuk Realty Co., $2,500,000.

Apartment, New York, N. Y., A. Campagna, $5,000,000.

Recent Unit-Bids Throughout the Country

Unit prices of various materials and operations, applying on several of the more important contracts recently awarded, are compared in the accompanying table. Materials and operations, though very similar in nature, show diversity of unit costs according to geographical location. For instance, 3 mi. of concrete paving cost $28,333 per mi. in Tulsa, Okla., as against 1 mi. of concrete highway in the state of Washington at $42,583. Excavation of 2,780,000 cu.yd. of navigation channel at Lake Charles, La., cost 13.8c. per cu.yd., compared with 8,700 cu.yd. of channel excavation at Anamosa, Ia., at 48c. per cu-yd. Seventeen miles of gravel surfacing at Lake Village, Ark., cost $6,470.59 per mi., against 9 mi. of Louisiana state highway at $5,269.45 per mi. and 11.6 mi. in the state of Washington, at $4,994.22 per mi.

Large Contracts Let During Week

Among the week's announcements of contracts awarded in Construction News, pp. 187 to 200, are the following:

Power Plant, Florence, Ala., to Alabama Power Co., Birmingham, Ala. $3,472,487.

Bank and Office, Pasadena, Calif., to Scofield Eng. Co., Los Angeles, $1,000,000.

High School, New York City, to Willetts Constr. Co., $2,057,000.

Bank, Seattle, Wash., to Puget Sound Bridge & Dredging Co., $1,250,000.

Temple, Springfield, Mass., to A. E. Stephens Co., $1,000,000.

Next week—"Brick and Cement Imports Not Large but Increasing."

A tabulation of fifty large contracts awarded this year is being prepared for early publication in this section.

Freight Loadings at New High Mark

More cars were loaded with revenue freight during the week which ended on Sept. 1 than during any week heretofore in history. The total for the week, 1,092,567 cars. This exceeded by 22,635 cars the previous record, which was established during the week ended Aug. 25 this year, when 1,069,932 cars were loaded.

UNIT PRICES OF MATERIALS A ND OPERATIONS ON RECENT CONTRAC TS LET

Cables for Delaware River Bridge, Philadelphia

Pounds		Per Lb.
13,500,000	wire cables	$0.18
50,000	suspender ropes	1.60
180,000	steel castings	0.15
30,000	structural steel shims	0.20
30,000	c.i. separators	0.10

Excavation

Cu.Yd.		Per Cu.Yd.
2,780,000	navigation channel, Lake Charles, La.	$0.138
270,000	navigation channel, Lake Charles, La.	1.695
106,660	earth, Anamosa, Ia.	0.22
8,700	channel change, Anamosa, Ia.	0.48

Grading

		Per Mile
8.474 mi.	road, 18 ft. wide, Garnett, Kan.	$1,879.73

Surfacing

17 mi.	gravel, Lake Village, Ark.	$6,470.59 per mi.
9 mi.	gravel, Louisiana	5,269.45 per mi.
11.6 mi.	crushed stone or gravel, Washington	4,994.22 per mi.
63,000	cu.yd. gravel, Napoleon, N. D.	0.4683 per cu.yd.

Tile in Anamosa, Ia.

		Per Ft.
30,690 ft.	6 in.	$0.122
540 ft.	8 in.	0.178
1,325 ft.	12 in.	0.34

Paving in Eight Centers

25,000	sq.yd. removing old macadam and replacing with new bituminous macadam, Providence, R. I.	$1.38 per sq.yd.
12,800	sq.yd. bituminous, Houston, Tex.	3.575 per sq.yd.
11,050	lin.ft. rein.-con., Waynesburg, Pa.	10.93 per ft.
5 mi.	bitulithic, 20 ft. wide, Alabama City, Ala.	7,671.20 per mi.
1 mi.	monolithic brick, Canton, O.	60,943.00 per mi.
1 mi.	Trinidad asphalt, 30 ft., Canton, O.	49,000.00 per mi.
3 mi.	concrete, Tulsa, Okla.	28,333.33 per mi.
0.83 mi.	vibrolithic, South Dakota	32,077.11 per mi.
1 mi.	concrete, Washington	42,583.00 per mi.

Dredging Willapa Harbor, Wash.

8,035	cu.yd. ledge rock	$9.30 per cu.yd.
2,400	cu.yd. other material	1.50 per cu.yd.

Waterworks, Detroit, Mich

Pipe:		
100 tons,	class C, 42-in., c.i.	$55.00 per ton
1,504 tons,	class C, 8-in., c.i.	56.70 per ton
105,600 ft.	8-in. centrifugal	0.878 per ft.

Value of September Contracts 24 Per Cent Heavier Than For Same Month Last Year

Total of 708 Awards During September, Average Value $244,452, Compared With 820 in August, Averaging $172,681

The total value of contracts awarded on large engineering construction projects, in the four September issues of *Engineering News-Record*, reached $173,072,000 as compared with $141,599,000 in the five issues of August. This represents an average weekly value of $43,268,000 for September, against $28,319,800 during the preceding month.

The weekly average of $43,268,000 for the month of September represents an increase in money value of nearly 26 per cent above the weekly average for the corresponding period in 1922. September, 1922, contracts totaled $138,648,000.

Minimum costs observed in Construction News on each class of construction are as follows: Water-works, $15,000; other public works, $25,000; industrial construction, $40,000 and commercial buildings, $150,000.

Of the $173,072,000, a total of $6,132,000 represented Canadian awards, which fell off heavily from August.

Streets and roads gained 6 per cent in total money value during the month, while buildings increased 33 per cent and excavations, 50 per cent. September totals for bridge construction and miscellaneous work, tripled those for the month preceding. Water-works, sewers, industrial construction and Federal Government work fell off somewhat during September.

Among the large projects awarded during September were the following: The Moffat tunnel project in Colorado, $6,075,000; sewage treatment works, Chicago, Ill., $5,602,636; a nineteen story office building in Dallas, Tex., $5,000,000; bridge over the Carquinez Straits, $4,500,000; a 260 ft. dam at Danville, Ky., $4,000,000; and a hospital at Cleveland, O., $3,300,000.

The actual physical volume of construction represented by September contracts is 6 per cent greater than September, 1922; 50 per cent heavier than for the corresponding period in 1921 and twice the volume of September, 1920, lettings.

Engineering News-Record Construction Cost Index Number

October, 1923	220.30
September, 1923	221.50
October, 1922	188.60
Peak, June, 1920	273.80
1913	100.00

Engineering News-Record's Construction Cost Index Number declined 1.2 points since last month, owing to drop in lumber. Prices of other basic building materials remained unchanged during the month. The average rate for common labor is still 54c. Thus, general construction cost is 17 per cent higher than one year ago and 20 per cent under the peak; it is 120 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Monthly	
September, 1923 (*4 issues of E. N.-R.*)	137
August, 1923 (*5 issues of E. N.-R.*)	111
September, 1922 (*4 issues of E. N. R.*)	129
1913	100
Yearly	
1922 (entire year)	130
1921 (entire year)	88
1920 (entire year)	91
1913	100

Engineering News-Record's Construction Volume Index Number is 137 for the month of September, and 130 for the whole of 1922, as against 100 for 1913. This means that the actual volume of construction in 1922 (not the mere money-value of the contracts let that year) is 30 per cent above the volume of construction for 1913. Our monthly volume number, 137 for September, 1923, is really the increment of construction, and indicates the rate at which contracts are being let as compared with 1913 awards.

VALUE OF CONTRACTS LET IN THE UNITED STATES AND CANADA DURING SEPTEMBER, 1923

	New England	Middle Atlantic	Southern	Middle West	West of Mississippi	Western	Total United States	Canada	Total
Waterworks	.....	$211,000	$40,000	$1,970,000	$327,000	$281,000	$2,829,000	$52,000	$2,881,000
Sewers	$40,000	686,000	765,000	7,000,000	1,351,000	526,000	10,368,000	.....	10,368,000
Bridges	1,107,000	767,000	3,324,000	1,504,000	589,000	4,884,000	12,175,000	434,000	12,609,000
Excavations, drainage and irrigation	.....	1,198,000	1,183,000	469,000	253,000	10,000	3,113,000	247,000	3,360,000
Streets and roads	1,740,000	9,962,000	6,033,000	6,165,000	8,501,000	4,500,000	36,901,000	911,000	37,812,000
Industrial works	2,045,000	1,360,000	643,000	3,890,000	1,485,000	761,000	10,184,000	1,062,000	11,246,000
Buildings	1,413,000	23,209,000	4,509,000	10,530,000	11,114,000	15,579,000	66,354,000	1,930,000	68,284,000
Federal Government	207,000	587,000	114,000	195,000	408,000	773,000	2,284,000	.....	2,284,000
Miscellaneous	33,000	2,913,000	4,146,000	7,393,000	8,027,000	220,000	22,732,000	1,496,000	24,228,000
September, 1923	$6,585,000	$40,893,000	$20,757,000	$39,116,000	$32,055,000	$27,534,000	$166,940,000	$6,132,000	$173,072,000
August, 1923	4,308,000	30,933,000	11,974,000	34,425,000	24,962,000	21,555,000	128,157,000	13,442,000	141,599,000
July, 1923	8,897,000	34,633,000	24,065,000	42,044,000	25,666,000	19,718,000	155,023,000	8,436,000	163,459,000
Total 3 months	$19,790,000	$106,459,000	$56,796,000	$115,585,000	$82,683,000	$68,807,000	$450,120,000	$28,010,000	$478,130,000

Labor Rates and Conditions Throughout the Country

Fewer wage changes and a slight decrease in employment mark the industrial situation at the beginning of the autumn season.

Twenty-three wage changes were noted by the National Industrial Conference Board for the month ending Sept. 15, against seventy-seven during the preceding month. Of the twenty-three, twenty-two were increases and one a decrease.

Latest reports of the U. S. Department of Labor show a decrease in employment of only 0.45 per cent in one month.

Tremendous building programs continue in nearly all of the principal centers throughout the country. State and county highway construction is particularly active with a shortage of labor reported in some sections.

The average rate paid common laborers, pick and shovel men in construction operations, remains at 54c., the same as for July, August and September as against 53c. per hr. during June, according to *Engineering News-Record* figures. Local building conditions are as follows:

Baltimore—Scarcity of structural iron workers. Conditions nearing normal among hod carriers and common laborers; normal in other crafts.

Boston—Bricklayers scarce; other trades plentiful. Minimum carpenters' rate, $1, maximum, $1.10, against $1.05 per hr., last month.

Dallas—Excessive demand for bricklayers and carpenters; other crafts plentiful.

Denver—All building trades 100 per cent employed.

Detroit—Good supply of men for all trades available; no shortages noted.

Los Angeles—Construction active.

CURRENT BUILDING TRADES WAGE RATES PER HOUR

(Higher rates indicated by +, decreases by —)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.12½	$0.90	$0.70	$0.50	.....	$0.75	30@.35
Baltimore	1.50	1.00	.90@1.12½	.87½	$0.65	.80@1.00	30@.50
Birmingham	1.00	1.00	.50@1.00	.30@.40	.....	1.25	30@.40
Boston	1.25	+1.00@1.10	1.25@1.35	.82½	1.05	1.12½	55@.70
Cincinnati	1.25	1.05	1.05	.82½	1.05	1.05	45
Chicago	1.25	1.15	1.00@1.25	.88¾	1.10	1.25	82½
Cleveland	1.40	1.25	1.25	.87½	1.00	1.10	87½
Dallas	1.50	1.00	1.00	.40	.87½	1.00	30@.50
Denver	1.37½@1.50	1.12½	1.12½@1.18¾	.75@.81¼	1.00	1.15¾	35@.55
Detroit	1.12½	.80	.80@.90	.50@.60	1.00	.60@.80	50
Kansas City	1.37½	1.00	1.00@1.25	— 87½	1.00	1.07½	55@.60
Los Angeles	1.25	.87½@1.00	.87½@1.00	.62½	.....	1.00	50
Minneapolis	1.12½	.87½	.87½	.71½	.....	.87½	.50@.55
Montreal	—90@1.00	.65	.50	.35	.50	.65	+ 30@.35
New Orleans	+1.25	.90	+1.00	.65	.80	1.00	35@.40
New York	1.50	1.25	1.25@1.50	1.00	1.00	1.25	50@.75
Philadelphia	+1.50	1.12½	+1.02½	.70@1.00	1.00	1.10@1.12½	—45@.50
Pittsburgh	1.40	1.20	1.12½	1.00	1.12½	1.25	+ 70
St. Louis	1.50@1.75	1.50	1.25@1.37½	1.25	1.25	1.25@1.50	—45@100
San Francisco	1.25	1.00	1.00	81¼	1.00	1.12½	50@.55
Seattle	+1.25	1.00	+1.00@1.12½	.93¾	+1.00@1.12½	1.12½	+.56¼@.62½

Minneapolis—Labor conditions easy. Slump in building construction.

Montreal—Scarcity of structural iron workers; plenty of other building trades mechanics. Common labor rate down 5c. per hr. since last month.

New Orleans—Labor adequate to all demands.

New York—Wage conferences expected to begin during current month. Bonus agreements with many trades expire at end of the year. Bricklayers beginning to be plentiful; many accepting flat rate of $12 per day with no bonus. Scarcity of plasterers; those working six and a half days per week, with one hour overtime per day, receive $122.50 per week.

Pittsburgh—Bricklayers scarce. Continued demand for common laborers.

St. Louis—Bricklayers now receiving $1.50 will demand $1.75, Nov. 1. Carpenters' rate $1.50 per hr., effective Oct. 1.

San Francisco—While new work is not in sight to any appreciable degree, there is very little unemployment among members of the local building trades councils. The disastrous fire at Berkeley which destroyed over 600 dwellings will undoubtedly tend to keep down unemployment among building trades mechanics.

Seattle—Bricklayers advanced to $1.25 from $1.12½ per hr. Maximum rate for hoisting engineers and pile drivers, $1.12½, against $1 per hr. Minimum for common laborers, 56¼c., compared with 50c. per hr. last month.

Monthly Prices of Construction Materials

Ups and Downs of the Market

Pig Iron—Market weak, with prices tending downward. Iron still being piled up, despite high production cost due principally to labor. Quotations under $23 per ton for No. 2 foundry iron have been made at Birmingham.

Railway Supplies—Minimum on light rails, $43 at Pittsburgh mill, against $45 per ton, one month ago. St. Louis quotations at maximum of $43. Oak and cypress ties up 5c. in St. Louis. Standard spikes and track bolts higher in San Francisco and St. Louis. Light rail and track fastenings' markets dull, particularly in Chicago district.

Pipe—No changes in wrought steel, wrought iron or cast-iron pipe during month. Clay drain tile (New York) same price as year ago. Slight decline in sewer pipe in Baltimore. Four-inch sewer pipe advanced in New Orleans due to scarcity of that gauge.

Road and Paving Materials—Few changes in road oil and asphalt prices since last month. Baltimore reports drop of $3 in package asphalt and $1 per ton in bulk. Wood block firmer in Boston and New Orleans, due to increased costs of lumber, creosote oil and labor; slightly lower in Minneapolis and Atlanta.

Sand, Gravel and Crushed Stone—Gravel down 5c. per ton in Atlanta. Both sand and gravel lower in Baltimore. Sand and gravel being stocked for winter demands. Crushed stone, ¾-in., down 10c. in St. Louis and 25c. per cu.yd. in Minneapolis, during month.

Lime—Hydrated finishing, down 50c. in Philadelphia and $2 per ton in Dallas; up 50c. in Atlanta. Hydrated common, advanced 50c. in Atlanta and 60c. in Baltimore; declined 50c. per ton in Philadelphia. Lump finishing, dropped 20c. in Boston and rose 5c. per bbl. in Atlanta. Common lump down 69c. in Philadelphia and 60c. per bbl. in Dallas, due to increased output of Southern lime.

Cement—Stability of cement market unbroken in forty-six centers, reporting regularly to *Engineering News-Record*, excepting slight advances in Philadelphia and at Fordwick, Va., mill.

Structural Steel—New buying of plates and structurals extremely quiet. Numerous small orders, however, received for new plate tonnages. Bulk of plate tonnage for car and tank construction. New structural business firm at $2.50 base, but mostly confined to small tonnages. Plates quoted as low as $2.40 per 100 lb., Pittsburgh, with very small tonnages at $2.50. Bars at $2.40 base; buying more active for fourth quarter requirements.

Brick and Hollow Tile—Common brick down 25c. in Detroit, $1 in Atlanta and $2 per M. in Boston, during month; no advance reported. Slight decline in hollow tile in New York; no advances in twenty-one cities reporting.

Lumber—Increase in yellow pine orders and inquiries for fall trade. Fir timbers advanced $3 in San Francisco and yellow pine, declined $2 per M. ft. in New York, during month. No changes in hemlock and spruce. Pine down 50c. to $1 in Atlanta. Fir declined $1 per M. ft. in Minneapolis. Pine timbers advanced $1 in Philadelphia and $3 in Boston. Fir timbers rose $1 in Seattle and $1.25 to $2 per M. ft. in Minneapolis, due to Japanese demand.

Explosives—Slight decline in 40 per cent gelatin dynamite reported in St. Louis. Both 40 and 60 per cent advanced in Los Angeles.

Scrap—Iron and steel scrap prices weaker, particularly in Chicago district.

Linseed Oil—Raw oil declined 1c. per gal. f.o.b. New York, in month; dropped 2c. in Atlanta and 7c. per gal. in San Francisco.

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton—Quotations compiled by The Matthew Addy Co.:

	Oct. 4	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	$27.05	$30.55
Northern Basic	25@26	32.27
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	25.50	34.27
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	30.00	36.27
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	23.00	27.50
PHILADELPHIA		
Eastern Pa., No. 2X, (2.25@2.75 sil.)	26.25	36.64
Virginia No. 2 (silicon 2.25 @ 2.75)	30.17	37.17
Basic	26.00	34.00
Gray Forge	25.00	33.00
CHICAGO		
No. 2 Foundry Local (silicon 1.75 @ 2.25)	26.00	32.00
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	29.01	31.50
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	26.77	35.00
Basic	26.77	32.50
Bessemer	27.77	33.00

SCRAP—The prices following are per gross ton paid to dealers and producers f.o.b. New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$15.00	$11.50	16@16.50
Stove plate	12.00	12.00	16@16.50
No. 1 machinery cast	17.00	16.50	19.50@20
Machine shop turnings	8.00	4.00	12.50@13.50
Cast borings	9.00	5.50	14.00
Railroad malleable cast	15.00	12.50	20@21
Re-rolling rails	13.00	13.00	21.50@22
Re-laying rails		30.00	28.50@30.50
Heavy melting steel	12.00	16.00	

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	Oct. 4	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00		$43.00	$43.00
Standard openhearth rails	43.00	43.00	$40.00	43.00	43.00
Light rails, 8 to 10 lb.	43@45	45.00	2.00*	43.00	43.00
Light rails, 12 to 14 lb.	43@45	45.00	2.00*	43.00	43.00
Light rails, 25 to 45 lb.	43@45	45.00	2.00*	43.00	43.00
Rerolled Rails	38@40				

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	$1.50	$1.65
Chicago, Hardwood and Red Oak	1.25	1.40
Chicago, Empty Cell Creosoting (add'l)	.45	.50
San Francisco, Green Douglas Fir	.84	1.14
San Francisco, Empty Cell Creosoted Douglas Fir	1.70	2.25
St. Louis, White Oak	1.30	1.60
St. Louis (creosoted) (zinc treated)	1.70	2.05
St. Louis, Red Oak, plain	1.20	1.50
St. Louis, Sap pine-cypress	1.05	1.35

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh				San Francisco	Birmingham
	Oct. 4	One Year Ago	Chicago	St. Louis		
Standard spikes, ⅝-in. and larger	$3.15	$2.75@2.85	$3.00	$4.00	$5.00	$3.75
Track bolts	4.00	3.75@4.50	4.00	5.05	6.20	4.70
Standard section angle bars	2.75	2.40	2.75	4.00	4.00	3.10

PIPE

WROUGHT PIPE—The following mill discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1¼	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1¼	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	48%	50%	49%
2½ to 6 in. lap welded	44%	47%	46%

	Galvanised		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	34%	37%	36%
2½ to 6 in. lap welded	30%	34%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 15%. Cast iron, standard sizes, 17½% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham Mill	New York Oct. 4	New York One Year Ago	Chicago	St. Louis	San Francisco
4 in.	$53.00	$68.60	$60.30	$64.20	$61.60	$66.00
6 in. and over	49.00	63.60	55.30	60.20	57.60	62.00

Gas pipe and Class "A," $5 per ton extra; 16-ft. lengths, $1 per ton.

CLAY DRAIN TILE—The following prices are per 1000 lin.ft.:

	New York					
Size, In.	Oct. 4	One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$45.00	$45.00	$50.00	$62.50		$73.00
4	55.00	55.00	50.00	75.00	$76.50	83.00
5	80.00	80.00		100.00	97.75	108.00
6	105.00	105.00	85.00	175.00	127.50	133.00
8	170.00	170.00	195.00	187.50	212.50	199.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3		$0.105			$0.15	$0.12	
4		105	$0.11	$0.1175	.15	.15	$0.15
5		1575	.1375		.23	.18	.18
6	$0.24	.1575	.165	.1645	.23	.21	.21
8	.38	.245	.26	.26	.35	.30	.325
10	.57	.3675	.338	.364	.53	.42	.476
12	.72	.4725	.442	.468	.68	.54	.612
15	1.13†	.63	.65	.78†	.90	.90	.884
18	1.65†	.875	.85	1.092†	1.25	1.32	1.153
20	1.98†	1.05	1.125		1.50		
22	2.64†	1.40	1.375	1.456†	2.00		1.564
24	2.97†	1.575	1.625	1.456†	2.25	2.16	2.04
27	4.81†	2.795		2.95†	4.69†	3.00	3.34
30	5.33†	3.096		3.65†	5.94†	3.60	4.06
33	6.93†	4.14		4.45†	6.88†		4.99
36	7.91†	4.715		4.80†	7.50†		5.42

	3	5	8	12	24	36
Boston	$0.129	$0.199	$0.315	$0.603	$1.99†	$5.95†
Minneapolis			.40	.72	2.55	5.66†
Denver	.135*	.18*	.27	.47	1.70	
Seattle	.13		.36	.72‡	2.60†	
Los Angeles	.13	.165	.275	.475	1.65	
New Orleans	.145*	.168*	.28	.476	1.182	
Cincinnati	.12	.18	.28	.54	1.80	4.10†
Atlanta	.105*	.16*	.27	.455	1.75	
Montreal, *delivered*	.68‡	.45†	.70	1.35	4.50†	
Detroit	.117	.1755	.273	.5265	2.34†	6.15†
Baltimore	.117	.176	.273	.5265	1.755	3.9975
Kansas City, Mo.	.15*	.21*	.33½	.56		
Philadelphia	.12	.18	.28	.54	1.80	5.22½

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal minimum f.o.b. place named:

		Oct. 4	One Year Ago
New York, 45% asphalt	(at terminal)	$0.053	$0.055
New York, 65% asphalt	(at terminal)	.052	.055
New York, binder	(at terminal)	.06	.0625
New York, flux	(at terminal)	.06	.06
New York, liquid asphalt	(at terminal)	.048	.065
St. Louis, 50@60% asphalt		.0565	
St. Louis, 40@50% asphalt		.0535	
Chicago, 40–50% asphalt		.0525	.0525
Chicago, 60–70% asphalt		.055	.055
Dallas, 45% asphalt		.0495	.10
Dallas, 55% asphalt		.0455	.13
Dallas, binder		.061	.15
San Francisco, binder, per ton		9.50*	13.00*

* F.o.b. Oelum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$23.00*	$15.00†
Boston (*Mexican*)	21.50	17.50
Chicago (*Stanolind*)	22.25	16.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	17.00	11.00
Dallas (*Texas*)	27.10	21.10
Seattle, "*D*" *grade, California, f.o.b. Richmond*	24.75	20.50
Denver (*California*)	24.00	
Minneapolis *f.o.b. Twin Cities* (*Stanolind*)	25.45	19.10
St. Louis (*Mexican*)	29.50	24.50
Baltimore (*Standard Oil*)	*18.00*	*14.00*
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	26.00	23.50
Detroit (*Mexican*)	22.47	18.40
Cincinnati (*Kentucky Rock*)	17.50	13.50
Maurer, N. J. (*Bermudez*)	28.00	26.00
Maurer, N. J. (*Mexican*)	21.50	18.50
Philadelphia (*Mexican*)	20.00	15.00
Kansas City (*Texas*)	27.30	22.30
Los Angeles "*D*" *grade, California, f.o.b. El Segundo Refinery*	17.00	11.00

*F.o.b. Bayonne, N. J.
†F.o.b. Marcus Hook, Pa.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade 1)	5-in. granite, 30 blocks per sq.yd.	$138.00 per M.
Chicago	About 4x8x4 dressed	3.50 per sq.yd.
	About 4x8x4 common	3.10 per sq.yd.
San Francisco	Basalt block 4x7x8	70.00 per M.
Boston	5-in. granite, 28 blocks per sq.yd	*128.00* per M.
Atlanta	Granite	2.66 per sq.yd.
Detroit	5-in. Granite	106.00 per M.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4 x 8 x 4	3.25 per sq.yd.
Cincinnati	Granite	138.00 per M.
St. Louis	4x8x4 dressed	3.15 per sq.yd.
	4x8x4 common	2.95 per sq.yd.
Kansas City	Granite	3.55 per sq.yd.
Philadelphia	Granite	3.75 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft wide	$0.22 per sq.ft.
	Manhattan, 4 ft. wide	.22 per sq.ft.
	Queens, 5 ft. wide	.24 per sq.ft.
	6x24-in. cross-walk	1.10 per lin.ft.
Chicago	18 in. wide	per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5 x 16 in., 80c.; 5 x 20 in., Queens, 85c. *St. Louis*: Class "A" straight, delivered, 5 x 16 in., $1.45 per lin.ft. *Chicago*: 5 x 8 in., $1.65; 6 x 8 in., $1.95 per lin.ft. delivered.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York (*delivered*)	3	16	$2.58
New York (*delivered*)	3½	16	2.79
Boston	3½	18	**2.60**
Chicago	4	16	3.00@3.25
Chicago	3½	16	2.50
St. Louis	3½	16	2.55
St. Louis	4	16	2.90
Seattle	4	16	Off market
Minneapolis	3½	16	*2.70*
Atlanta	3½	16	*1.90*
New Orleans	3	16	**2.50**
New Orleans	3½	16	**2.81**
New Orleans	4	16	**3.15**
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	2.84
Detroit	4	16	3.00
Cincinnati	3½	16	2.38
Kansas City	4	16	2.75
Philadelphia	4	16	None used

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In. Oct. 4	Gravel 1½ In. One Year Ago	Gravel ¾ In. Oct. 4	Gravel ¾ In. One Year Ago	Sand Oct. 4	Sand One Year Ago
New York	$1.75	$1.75	$1.75	$1.75	$1.25	$1.00
Denver	1.90	1.75	1.90	1.75	1.00	0.75*
Chicago	2.00	2.00	2.00	2.00	2.00	2.00
St. Louis	2.30	1.40†	2.35	1.45†	2.10	1.20†
Seattle	1.25	1.00	1.25	1.00	1.25	1.00
Dallas	2.38	2.25	2.38	2.25	1.89	2.25
Minneapolis	1.85*	1.75	1.85*	1.75	1.25	1.00
Cincinnati	1.50†	1.40	1.50†	1.40	1.30†	1.15
San Francisco	2.15	2.25	2.15	2.25	1.50	1.50
Boston	1.40†		1.40†		1.10†	
New Orleans	2.85	2.85	2.85	2.85	1.25	1.35
Los Angeles	2.50	1.50†	2.50	1.50†	1.75	1.35†
Atlanta	*1.85*†	2.00†	*1.85*†	2.00†	1.24†	1.35†
Detroit	1.62	2.00	1.62	2.00	2.02½	2.00
Baltimore	*1.40*	1.40	*1.60*	1.60	*0.70*†	0.70*†
Montreal	1.25†	1.25†	1.50†	1.50†	1.25†	1.25†
Birmingham (Crushed slag used instead of gravel)					1.30†	1.20†
Philadelphia	2.00†	1.70	2.00†	1.75	1.50†	1.65
Kansas City	1.75	2.00	1.60	2.00	0.66*†	0.66*†

New York—Grits, $1.75 per cu. yd.; ready mixed, $2.00
Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.
* At pit.
† Per ton.

CRUSHED STONE—Price for cargo or carload lots f.o.b. [illegible] unless stated otherwise, is as follows, per cu.yd.:

	1½ In. Oct. 4	1½ In. One Year Ago	¾ In. Oct. 4	¾ In. One Year Ago
New York	$1.65	$1.65	$1.75	$1.75
Chicago	2.00	1.60	2.00	1.60
St. Louis	*1.75*	2.10	*1.90*	2.20
Dallas	*2.38*	1.65	*2.38*	1.65
San Francisco	2.15	2.25	2.15	2.25
Boston	1.60*		1.60*	
Minneapolis	*1.85*	2.00	*2.00*	2.25
Kansas City	1.50	2.00	1.50	2.50
Denver	3.50	3.50	3.50	3.50
Seattle	3.00	3.00	3.00	3.00
Atlanta	2.00*	1.90*	2.00*	1.90*
Cincinnati	1.65*	1.55	1.65*	1.55
Los Angeles *delivered*	2.75	1.75*	3.00	1.85*
Detroit	1.75	1.90*	1.75	1.90*
Baltimore	2.50	1.70*	2.55	1.60*
Montreal	1.80*	1.50*	1.90*	1.90*
Philadelphia	2.00*	1.75*	2.00*	1.60*
Pittsburgh	2.85	2.85	2.85	2.85
Cleveland	3.25*	3.00*	3.25*	3.00*

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Steubenville District	1.40	1.40	2.00	1.40
Ironton District	1.40	1.40	2.00	1.40
Easton, Catasauqua, Pa.	0.85	0.90	2.50	
Birmingham, Ala.	1.05	1.15	2.05	0.80
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.45	1.45	1.45	1.25
Eastern Pa. and Northern N. J	1.20	1.20	2.50	1.20
Western Pennsylvania	1.25	1.25	2.00	1.25
Longdale and Glen Wilton, Va.	1.25	1.25	2.50	1.00
Toledo, Ohio	1.50	1.50	1.50	1.50

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$18.20	$13.10	$3.75*	$3.00@3.25*
Chicago	20.00	20.00	1.50†	1.50†
St. Louis	23.20	20.00	1.87½†	1.87½†
Boston	22.50	16.00	*4.10**	2.60*
Dallas	*20.00*	....	....	*1.75*†
Cincinnati	16.80	14.30	....	....
San Francisco	22.00	....	....	2.10†
Minneapolis	25.50	21.00 (white)	1.70†	1.50†
Denver	24.00	....	....	2.70†
Detroit	21.00	20.00	....	20.00‡
Seattle, *paper sacks*	24.00	....	2.80†	
Los Angeles	....	18.50	....	*2.00*†
Baltimore	24.25	**17.85**	2.55	
Montreal	21.00	21.00	....	10.00‡
Atlanta	**23.00**	**14.50**	**2.30**†	1.50†
New Orleans	....	....	2.40†	1.85†
Philadelphia	*23.00*	*16.00*	....	*1.24*†
Kansas City	28.00	24.00	3.12*	2.96*
Birmingham	14.25	13.50	1.90†	1.65†

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl. Minneapolis quotes brown common lump lime; Kelly Is. white is $1.80. Sheboygan $1.70. New York quotes hydrated lime "on cars" in paper sacks, lump lime "alongside dealers docks" or "on cars."

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b. exclusive of bags:

	Oct. 4	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.75	1.75
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.80	
St. Louis (Carney)	2.35	1.87
Birmingham (Magnolia) pozzolan cement	2.10	....

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Oct. 4	One Month Ago	One Year Ago
New York, del. by truck	$2.70@2.80	$2.70@2.80	$2.60@2.75
New York, alongside dock to dealers	2.30	2.30	2.55
Jersey City	2.48	2.48	2.73
Boston	2.78	2.90	
Chicago	2.20	2.20	2.20
Pittsburgh	2.24	2.24	2.24
Cleveland	2.46	2.46	2.46
Detroit	2.48	2.48	2.48
Indianapolis	2.41	2.41	2.41
Toledo	2.48	2.48	2.53
Milwaukee	2.37	2.37	2.37
Duluth	2.25	2.25	2.14
Peoria	2.41	2.41	2.41
Cedar Rapids	2.48	2.48	2.48
Davenport	2.43	2.43	2.43
St. Louis	2.45	2.45	2.35
San Francisco	2.63	2.63	2.71
New Orleans	2.90	2.90	3.30
Minneapolis	2.50	2.50	2.39
Denver	2.84	2.84	2.85
Seattle	2.90	2.90	2.90
Dallas	2.25	2.25	2.25
Atlanta	3.00	3.00	2.54
Cincinnati	2.54	2.54	2.59
Los Angeles	3.16	3.16	3.30
Baltimore	2.65	2.65	2.90
Birmingham	2.70	2.70	2.40
Kansas City	2.45	2.90	2.85
Montreal	2.25	2.25	2.78
Philadelphia	**2.96**	2.75	2.41
St. Paul	2.50	2.50	2.39

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.95	Hudson, N. Y.	$2.20
Universal, Pa.	2.00	Leeds, Ala.	2.20
Steelton, Minn.	2.06	Bannibal, Mo.	2.10
Fordwick, Va.	**2.20**	Lehigh Valley District	2.10
Mitchell, Ind.	2.10	Wyandotte, Mich.	2.30
Iola, Kan.	2.10	Alpena, Mich.	2.10
Mason City, Ia.	2.10	Richard City, Tenn.	2.20
La Salle, Ill.	2.10	Kingsport, Tenn.	2.20

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.95	$1.02	$1.24	$1.04	$1.12	$1.21
049	28	1.20	1.30	1.58	1.32	1.38	1.52
068	35	1.47	1.59	1.94	1.62	1.67	1.87
093	45	1.89	2.04	2.50	2.08	2.00	2.42
126	57	2.34	2.53	3.09	2.59	2.55	2.99
153	68	2.79	3.02	3.60	3.08	3.15	.....
180	78	3.20	3.47	5.22	3.54	3.47	.....
245	103	4.22	4.57	4.60	4.66	4.58	.....
287	119	4.88	5.28	6.44	5.39	5.26	6.00
336	138	5.66	6.13	7.39	6.25	6.11	.....
395	160	6.56	7.10	8.67	7.25	7.12	.....
			PAVING				
036P	17	$0.72	$0.78	$0.95	$0.79	$0.76	.....
053P	24	1.02	1.10	1.35	1.12	1.07	.....
072P	31	1.29	1.40	1.71	1.42	1.39	.....
097P	40	1.66	1.80	2.20	1.83	1.90	.....
049R	24	.....	1.10	.....	1.12	1.07	.....
067R	31	.....	1.40	.....	1.42	1.39	.....
089R	40	.....	1.80	.....	1.83	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq. ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Gage	Weight	*New York	Chicago	St. Louis	San Francisco	Dallas
27Dia.	2.3	$22.00	$21.25	$20.72	$20.00	$25.50
26 "	2.5	22.00	22.50	22.39	19.11	27.58
25 "	3.0	22.00	25.25	24.93	.....	30.71
24 "	3.4	24.00	27.25	27.10	24.09	33.16
22 "	4.33	27.00	31.75	32.27	.....	35.10

*Price to contractors at warehouse or delivered on job in Manhattan, Bronx or Brooklyn.

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
¼ and larger..	$2.40	$2.65	$3.54	$3.20	$3.35	$3.80	$3.65
⅜	2.45	2.75	3.59	3.25	3.50	3.85	3.75
½	2.50	2.85	3.64	3.30	3.55	3.90	3.85
⅝	2.65	2.90	3.69	3.45	3.75	4.05	4.05
¾	2.90	2.95	4.04	3.70	4.35	4.30	4.65

Includes 15c charge for cutting to lengths of 2 ft. and over. Twisted bars cut to length take extra of 27½c. per 100 lb.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
¼ and larger	$2.30	$3.05	$3.50	⅝.....	$2.55	$3.30	$3.75
⅜ in.....	2.35	3.10	3.55	¾.....	2.80	3.50	4.00
½.....	2.40	3.15	3.60	.....	.....	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Oct. 4	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.).....	$23.65	$23.65	18@$20.20	$46.50	$54.00
New York (at dock)...	20.00	20.00	15@17	.....	.....
Chicago.....	11.00	11.00	11.00	34.00	42.00
St. Louis, salmon.....	16@18	16@18	14.00	38@40	40@42.50
Denver, salmon.....	12.00	12.00	12.00	.....	.....
Dallas.....	13.10	13.10	10.90	33.00	.....
San Francisco.....	15.00	15.00	15.00	.....	.....
Los Angeles (del.).....	15.50	15.50	15.00	(not used)	
Boston (del.).....	*21.00*	23.00		48.25	56.00
Minneapolis (del.).....	17@19	17@19	18@19	.....	.....
Kansas City.....	14.50	14.50	14.50	.....	.....
Seattle.....	15.00	13.00	14.00	55.00	.....
Cincinnati.....	17@20	17@20	17.00	45.00	50.00
Montreal.....	16.50	16.50	16.00	100.00‡	68.00
Detroit (del.).....	*18.25*	18.50	16.50	38.50	41.50
Baltimore (del.).....	21.00	21.00	20.00	40.00	45.00
Atlanta.....	*11.00*	12.00	12.00	40.00	45.00
New Orleans.....	18.75	18.75	15.75	.....	.....
Birmingham.....	*13@15*	13.50@16	12.50	.....	.....
Philadelphia.....	22.00	22.00	19@24	38.00	46.00
Pittsburgh (del.).....	16.00	16.00	16.00	.....	.....
Cleveland.....	16.00	16.00	16.00	.....	.....

*For paving blocks 3½x8½x3 and 3½x8½x4 respectively. †F.o.b. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Oct. 4 on Trucks*	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12...	*$0.1179*	$0.1230	$0.0724	$0.135	$0.089	$0.108	.....
6x12x12...	*.1769*	.1844	.0996	.....	.122	.156	.....
8x12x12...	*.2211*	.2305	.1358	.23	.162	.244	*$0.1968*
10x12x12...	.....	.....	.1695	.....	.186	.....	*.2442*
12x12x12...	.....	.....	.1937	.....	.232	.....	*.3175*

* 5 per. off for cash.

	4x12x12	8x12x12	12x12x12
Boston.....	$0.13	$0.24	.....
Minneapolis (f.o.b. cars).....	.0736	.12125	$0.214
Minneapolis (delivered).....	.0816	.13375	.234
Cincinnati.....	.0815	.153	.....
Kansas City.....	.085	.135	.....
Denver.....	.065	.123	.188
Seattle (delivered).....	.11	.25	.36
Los Angeles factory.....	.1042	.1880	.....
New Orleans.....	.12	.23	.....
Detroit (delivered).....	.1145	.2147	.27
Montreal.....	.115	.225	.30
Baltimore.....	.125	.27	.....
Atlanta.....	.102	.175	.....
Dallas.....	.115	.....	.....
Birmingham.....	.11	.18	.....
Pittsburgh (delivered).....	.068	.128	.179
Cleveland.....	.09	.172	.....

San Francisco and New York quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburgh and Birmingham, together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.....	$2.50	$2.75	$3.64	$4.20	$3.45	$3.40	$3.60
Channels, 3 to 15 in...	2.50	2.75	3.64	4.20	3.45	3.40	3.60
Angles, 3 to 16 in., ¼ in. thick.....	2.50	2.75	3.64	4.20	3.45	3.40	3.60
Tees, 3 in. and larger...	2.50	2.75	3.64	4.20	3.45	3.40	3.60
Plates, ¼ in. thick and heavier.....	2.50	2.75	3.64	4.30	3.45	3.40	3.60

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York, Oct. 4	New York, One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in. and larger	$3.00@3.25	$4.40	$3.85	$3.75	$4.15	$5.00	$4.90

CONE HEAD BOILER

½ in. and larger	$3.10@3.35	$4.50	$3.95	$3.85	$4.35	$5.10	$5.00
⅝ and ¾.....	3.25@3.50	4.66	4.11	4.00	4.70@4.95	5.25	5.15
⅞ and ⅞.....	3.50@3.75	4.90	4.35	4.20	4.95@5.10	5.50	5.40

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in. take an extra of 25c.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire.....	$3.00	$3.80	$4.25	$4.25	$3.34	$4.95
Cut.....	.....	4.45	5.80	5.75	*3.64*	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½.....	$9.85	$7.65	$8.00
⅝.....	7.80	$6.30	7.75
¾.....	7.75	$6.15	7.70

Pittsburgh base in lots of 200 kegs or more, $3.50

PREPARED ROOFINGS—Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $2.50 per roll in less than carload lots f.o.b. Philadelphia.

Single shingles, red and green slate finish, cost $5.75 per square (sufficient to cover 100 sq.ft.) in less than carload lots, f.o.b. Philadelphia. Strip shingles (4 in 1) f.o.b. Philadelphia, l.c.l., *$5.55* per square.

ROOFING MATERIALS—Prices f.o.b. New York, in less than carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton.....	$67.50
Tar pitch (in 400-lb. bbl.), per 100 lb.....	1.62½
Asphalt roofing (in barrels), per ton, f.o.b. plant*.....	38.75
Asphalt felt (light), per ton, f.o.b. plant*.....	75.00
Asphalt felt (heavy), per ton, f.o.b. plant*.....	75.00

* Delivered in Metropolitan Dist., $3.00 additional.

WINDOW GLASS—Double strength, box list, united inches, 34, "AA" grade, at discount of *84@85* per cent from standard lists, f.o.b. New York; "A" grade less 86@87 per cent and "B" grade, *88@89* per cent.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10.....	$3.00	$4.45	$4.15	$5.25	$4.59
No. 12.....	3.10	4.50	4.20	5.30	4.64
No. 14.....	3.20	4.55	4.25	5.35	4.69
No. 16.....	3.40	4.65	4.35	5.40	4.79
Black					
*Nos. 18 and 20.....	*3.60@3.70*	5.00	5.05	5.60	4.95
*Nos. 22 and 24.....	*3.65@3.75*	5.05	5.05	5.65	5.00
*No. 26.....	*3.70@3.80*	5.10	5.10	5.70	5.05
*No. 28.....	*3.75@3.85*	5.20	5.20	5.70	5.15
Galvanized					
No. 10.....	4.00	5.35	5.35	5.50	5.15
No. 12.....	4.10	5.45	5.45	5.60	5.25
No. 14.....	4.10	5.45	5.45	5.75	5.25
Nos. 17 to 21.....	4.40	5.75	5.74	5.90	5.55
Nos. 22 and 24.....	4.55	5.90	5.90	6.05	5.70
*Nos. 25 and 26.....	4.70	6.05	6.05	6.20	5.85
*No. 28.....	5.00	6.35	6.35	6.50	6.15

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Oct. 4	New York: One Year Ago	Chicago: Oct. 6	Chicago: One Year Ago
Raw in barrels (5 bbl. lots).....	*$0.95*	$0.91	$1.14	$0.97

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Oct. 4	1 Yr. Ago	Oct. 4	1 Yr. Ago
Red	14.00	12.75	15.50	14.25
White	14.00	12.75	14.00	12.75

LUMBER

Prices wholesale, per M. ft. b.m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$40.00	$41.00	$42.00	$45.00
3x6 and 8	40.00	41.00	42.00	45.00
4x4-6 and 8	40.00	41.00	42.00	45.00
3x10 and 12	40.00	41.00	42.00	45.00
3x14	42.00	42.00	44.00	46.00
4x10 and 12	40.00	41.00	42.00	45.00
4x14	42.00	42.00	44.00	46.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$42.00	$44.00	$46.00
6x14	47.00	49.00	51.00
8x10	42.00	44.00	46.00
8x14	47.00	49.00	51.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York*		Chicago	
	20 Ft. and Under	22-24 Ft.	20 Ft. and Under	22-24 Ft.
3x4 to 8x8	*$48.00*	*$49.00*	$45.50	$47.50
3x10 to 10x10	*52.00*	*53.00*	51.50	53.50
3x12 to 12x12	*56.00*	*57.00*	58.50	60.50
3x14 to 14x14	*63.00*	*66.00*	64.50	66.50
3x16 to 16x16	*68.00*	*69.00*	72.50	74.50
3x18 to 18x18	*82.00*	*83.00*	82.50	84.50
4x20 to 20x20	*92.00*	*93.00*	.....	.....

*Wholesale price to dealers; to contractors, delivered from lighters or cars to job, $5 additional. Short leaf pine costs $3 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12 x 12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir	Hemlock	Spruce	P.	Fir
Boston	$65.00	.....	$60.00	$60.00	$85.00	.....
Seattle	.....	$28.00	.....	.....	.....	$29.00
New Orleans	28.00	.....	.....	.....	31.00	.....
Baltimore	33.50	53.00	53.00	60.00	*38.00*	53.00
Cincinnati	40.00	75.00	75.00	90.00	44.00	80.00
Montreal	50.00	.....	.....	.....	70.00	90.00
Los Angeles	.....	50.00	.....	.....	.....	51.00
Denver	.....	43.25	.....	.....	.....	54.00
Minneapolis	42.00	43.75	41.50	.....	44.00	45.75
Atlanta	*35.00*	.....	.....	.....	*39.00*	.....
Dallas	47.50	.....	.....	.....	52.25	.....
Kansas City	43.25	.....	.....	.....	56.25	.....
Birmingham	30@35	.....	.....	.....	40@45	.....
Philadelphia	64.00	62.00	62.00	77.00	75.00	73.00
Detroit	45.75	50.25	.....	.....	58.75	50.25
St. Louis	44.00	.....	.....	.....	56.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir	Hemlock	P.	Fir
Boston	$50.00	*$50.00*	$50.00	$58.00	.....
Seattle	.....	24.00	.....	.....	$26.00
New Orleans	72.00	.....	.....	31.00	.....
Baltimore	60.00	44.00	44.00	34.00	50.00
Cincinnati	76.00	81.00	76.00	35.00	90.00
Montreal	.....	50.00	37.00	45.00	45.00
Los Angeles	.....	45.00	.....	.....	.....
Denver	.....	34.25	34.25	.....	34.25
Minneapolis	42.00	*39.75*	39.50	38.25	*36.25*
Atlanta	*19.50*	.....	.....	*29.00*	.....
Dallas	47.50	.....	.....	50.83	.....
Kansas City	47.50	.....	.....	36.00	.....
Birmingham	26@30	.....	.....	38@40	.....
Philadelphia	33.50@34	60.00	46.00	53.00	68.00
Detroit	49.50	37.00	.....	42.50	40.50
St. Louis	40.00	.....	.....	29.00	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M.ft. to contractors.
Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.
Denver—Quotes dealers price to contractors on large projects.
St. Louis—Wholesale price to contractors, f.o.b. cars, $3 per M.ft. additional.
Seattle—Price to contractors, delivered.
Dallas—Wholesale to contractors, $10 per M.ft. additional.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

MISCELLANEOUS

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Oct. 4	One Month Ago	One Year Ago
$2.65	$2.65	$2.35

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Hercules red strand, all constructions	20%
Patent flattened strand, special steel wire rope	20%
Patent flattened strand, iron rope	5%
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington Discount: 5 points less than discount for Eastern territory.
Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.
Arizona: Discount 10 points less than discount for Eastern territory.
Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.
North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¼-in. the price is ¼ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft., ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; 1¼-in., 2 ft. 4 in. Following is price per pound for ¼-in. and larger, in 1200-ft. coils:

Boston	*$0.16½*	New Orleans	*$0.18½*
New York	*.18*	Los Angeles	.20
Chicago	.18	Seattle	.18
Minneapolis	*.18½*	St. Louis	.19½
San Francisco	*.16*	Montreal	.22
Atlanta	*.19*	Detroit	.20
Denver	*.17½*	Baltimore	.18
Cincinnati	*.19*	Kansas City	.21½
Dallas	.21	Birmingham	.20½
Philadelphia	.19		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.295
Boston	.24	.26
Kansas City	.2225	.2475
Seattle	.165	19
Chicago	.22	.25
Minneapolis	.1917	.2123
St. Louis	*.2225*	.2475
Denver	.2025	.2275
Dallas	.225	.305
Los Angeles	.1975	.2225
Atlanta	.23	.2575
Baltimore	.22	.23
Cincinnati	.225	.25
Montreal	.195	.235
Birmingham, *delivered*	.16	.17
New Orleans	.195	.22
San Francisco	.1625	.1925
Philadelphia	.215	.240

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f. o. b. New York:

Sulphate of aluminum, in bags, per 100 lb.	$1.40@1.50
Sulphate of copper, in bbl., per 100 lb.	*5.00@5.15*
Soda ash, 58%, in bags, per 100 lb.	1.51
Chlorine, liquid, cylinders, 100 lb., per lb.	.09
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	2.00@2.10

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.31	Detroit	$0.29
Birmingham	.58	Kansas City	.735
Boston	.365	New Orleans	.67
Buffalo	.265	New York	.34
Chicago	.34	Pacific Coast (all rail)	1.34†
Cincinnati	.29	Philadelphia	.32
Cleveland	.215	St. Louis	.43
Denver	1.27*	St. Paul	.60

* Minimum carload, 40,000 lb.
† Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.